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NAVAL AIR ENGINEERING CENTER

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ENGINEERING DEPARTMENT (SI)
LAKEHURST, NJ 08733

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10 W. R. Clarke
F. C. Briggs, Jr

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16 TECHNICAL DATA REQUIREMENTS
FOR
SHIPBOARD AND SHOREBASED
VERTICAL/SHORT TAKEOFF AND LANDING (V/STOL)
AIRCRAFT, Revision A

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PREPARED BY W. R. Clarke

W. R. Clarke

F. C. Briggs Jr.

F. C. Briggs, Jr.

APPROVED BY N. Vaidich

N. VAIDICH

NOTICE

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DISCLAIMER NOTICE

1. Scope. This document defines the V/STOL aircraft technical data requirements for the Naval Air Systems Command and the Naval Air Engineering Center. The information and data shall cover both shipboard and shorebased operational areas of compatibility. Data submitted provides a central source of information to support the mission assignments with respect to shipboard suitability, ship/aircraft compatibility, aircraft spotting studies, aircraft proposal evaluation, and aviation safety.

For solicited and unsolicited proposals, provide the technical information required in accordance with WR-94 and the items of this report preceded by an asterisk (*). For Navy Contracts requiring data submission under MIL-D-8706, submit all of the data of this report as specified in MIL-D-8706.

The timely submittal of requested data is emphasized due to the long leadtime required for advanced planning and coordination with shipyard availability schedules, new ship construction programs and deployment schedules. It is desired that the data be submitted as a total package in the sectional format of this report to provide continuity in presentation and stowage. When data, such as aircraft performance and engine operating limitations, is not available for submission in the total package, such data shall be submitted separately as soon as it is available and identified for insertion into the report. Classified data shall be presented as a separate appendix and identified relative to the appropriate section of this report.

A glossary of abbreviations, definitions and symbols that are in general use within the aviation community is included in the following pages. If abbreviations, definitions or symbols which are used in presentation of data are not listed herein or in referenced documents, they shall be defined by the contractor or organization submitting the data.

Each page of data submitted in response to this report shall be identified by the aircraft model designation and submittal date to facilitate filing and revision update.

TABLE OF CONTENTS

Section			Page
Abbreviations, Definitions and Symbols			v
I		Aircraft Dimensions, General Arrangement and Aircraft Handling	I-1
	*1.	Aircraft Dimensions	I-1
	*2.	General Arrangement Drawings	I-1
	*3.	Landing Gear	I-2
	*4.	Danger Areas	I-2
	*5.	Wind-over-Deck (WOD) Requirements and Limitations	I-6
	6.	Blast Deflectors	I-13
	*7.	Aircraft Turnaround Time	I-13
	8.	Thrust Magnitude for Taxiing	I-16
	9.	Planform Change	I-16
	*10.	Major Component Removal and Replacement	I-16
	*11.	Aircrew Visibility	I-16
	*12.	Communications	I-17
	13.	State of the Aircraft	I-17
	14.	Aircraft Normal States	I-17
	15.	Weapons Carrying Capability	I-17
	*16.	Mission Profiles	I-17
	*17.	Operating Platforms	I-17
	*18.	Mixed Operations	I-20
	*19.	Deck Edge Effects, Angled Deck Limitations and Clearances	I-20
	*20.	Spotting Factors	I-20
	*21.	Compatibility with Ships Elevators	I-23

A

TABLE OF CONTENTS (Cont.)

Section			Page
II		Launch and Recovery Information; Aircraft Performance Limitations	II-1
	1.	Engine Operating Limitations	II-1
	*2.	Fuel Consumption	II-1
	*3.	Thrust Variation	II-3
	4.	Aerodynamic Data	II-3
	*5.	Stability and Control	II-3
	6.	Moments of Inertia	II-3
	7.	Single Engine Operation	II-3
	8.	Vertical Flight Regime	II-3
	*9.	Vertical Takeoff Capability	II-3
	10.	Transition	II-6
	*11.	Short Takeoff (STO) Distance	II-6
	12.	Conventional Takeoff (CTO) Distance	II-6
	*13.	Vertical Landing Capability	II-6
	*14.	Conventional Landing	II-10
	15.	Wave-off Capability	II-10
	16.	Glide Distance	II-10
	17.	Survival	II-10
	18.	Visual Landing Aids	II-10
	19.	Barricade Capability	II-10
	20.	Catapulting	II-12
	21.	Launch Data	II-12
	22.	Arrested Landing	II-27
	23.	Arresting Hook Parameters	II-27
	24.	Approach Airspeed	II-27
	*25.	Arresting Gear	II-27
	*26.	Ski Jump	II-30

LIST OF TABLES AND FIGURES

Table No.	Title	Page
I	Aircraft Normal States	I-18
II	Ship Dimensional Data	I-19

Figure No.	Title	Page
*I-1	Explosive Devices Danger Areas	I-3
*I-2	Electro-Magnetic Radiation Danger Areas	I-4
*I-3	Jet Blast & Personnel Danger Areas (Conventional/STO Mode)	I-5
*I-4	Jet Blast/Lift Efflux Danger Areas (VTOL Mode) (Deck Level)	I-7
*I-5a	Blast/Efflux Profile vs Thrust Angle Change (Planview Profile; Deck Level)	I-8
*I-5b	Blast/Efflux Profile vs Thrust Angle Change (Site Elevation Profile; Deck Level)	I-9
*I-6	Vertical Profile of Blast/Efflux for VTOL (No Wind)	I-10
*I-7	Vertical Profile of Blast/Efflux for VTOL (30 Knots Wind)	I-11
*I-8	Noise Danger Areas	I-12
I-9	Wind Limitations (Knots)	I-13
*I-10	WOD Limitations	I-14
*I-11	STO Distance vs Wind Over Deck	I-15
I-12	Conventional/V/STOL Aircraft Simultaneous Operating Environment	I-21
I-13	Angled Deck Edge Characteristics	I-22
II-1	Engine Operating Limitations	II-1
II-2	Fuel Consumption	II-2
II-3	Engine Thrust Required & Available vs Aircraft Velocity at Various Take-Off Weights	II-4
II-4	Thrust Variation due to Temperature and Velocity	II-4
II-5	Drag Polars	II-5

LIST OF TABLES AND FIGURES (Cont.)

Figure No.	Title	Page
II-6	Moments of inertia I_{XX}, I_{YY}, and I_{ZZ} vs Aircraft Weight	II-5
II-7	Vertical Takeoff Capability	II-7
*II-8	Short Takeoff Distance	II-8
*II-9	Conventional Takeoff	II-9
II-10	Conventional Landing	II-11
II-11	Shipboard Launch Geometry	II-13
II-12	Shipboard Heavy Weather Tiedown	II-14
II-13	Nose & Main Gear Load Deflection Curves	II-15
II-14	Main Wheel Tire Span vs Aircraft Wt	II-15
II-15	Tire Lateral Flexibility vs Aircraft Weight	II-16
II-16	Cornering Power vs Aircraft Weight	II-16
II-17	Normal Force Parameter vs Yaw Angle Parameter	II-17
II-18	Lift Coefficient vs Angle of Attack in the Take-Off & Landing Attitude for Various A/C Configurations	II-17
II-19	Pitching Moment Coefficient	II-18
II-20	Pitch Damping	II-18
II-21	Yawing Moment due to Yaw Velocity (Yaw Damping)	II-19
II-22	Rolling Moment due to Yaw Velocity	II-19
II-23	Side Force due to Yaw Velocity	II-20
II-24	Yawing Moment due to Rolling Velocity	II-20
II-25	Rolling Moment due to Roll Velocity (Roll Damping)	II-21
II-26	Side Force due to Rolling Velocity	II-21
II-27	Yawing Moment due to Side Slip	II-22
II-28	Rolling Moment due to Side Slip	II-22
II-29	Side Force due to Side Slip	II-23
II-30	Yawing Moment due to Rudder Deflection	II-23
II-31	Rolling Moment due to Rudder Deflection	II-24

A

LIST OF TABLES AND FIGURES (Cont.)

Figure No.	Title	Page
II-32	Side Force due to Rudder Deflection	II-24
II-33	Yawing Moment due to Aileron Deflection	II-25
II-34	Rolling Moment due to Aileron Deflection	II-25
II-35	Side Force due to Aileron Deflection	II-26
II-36	Minimum Catapult Take-Off Airspeed	II-26
II-38	Arresting Hook Snubber (Damper) Force vs Rotational Velocity of Hook	II-28
II-39	Damper Moment Arm vs Arresting Hook Position	II-28
II-40	Recommended Carrier Landing Approach Speeds	II-29

ABBREVIATIONS, DEFINITIONS AND SYMBOLS

The following abbreviations, definitions and symbols are in general use throughout the aviation community and are acceptable in presentation of data or in defining specific parameters. If abbreviations, definitions or symbols which are used in presentation of data are not listed below, they shall be defined by the contractor or organization submitting the data.

AB (or A/B)	Afterburner
ACFT (or A/C)	Aircraft
AD	Aerial Delivery
ADD	Airstream Direction Detector
ADI	Attitude Direction Indicator
AFCS	Automatic Flight Control System
AGL	Above Ground Level
Air Taxi	Jetborne flight at very low forward speed between two points on the ground.
AOA	Angle of Attack (also α)
AR	Aerial Recovery
AS	Antisubmarine Search
ASW	Antisubmarine Warfare
b	Wing span, feet
C-1/2	Number of cycles for the lateral oscillations to damp to half amplitude. The inverse of damping parameter.
C_{N_a}	Airplane normal force coefficient
CAS	Calibrated Air Speed
CCA	Carrier Controlled Approach
CG	Center of Gravity
CL	Conventional Landing; also Climb
CO	Air-to-Air Combat; also Carbon Monoxide
COAT	Corrected Outside Air Temperature
CR	Cruise
CRT	Combat Rated Thrust

	CTO	Conventional Takeoff
A	Cutback	Reduction of fan speed by engine speed limiter datum shift.
	D	Descent
	DE	Emergency Deceleration
	EAF	Expeditionary Airfield
	EAS	Equivalent Airspeed
	ED	Emergency Descent
	FD	Fuselage Datum
	FF	Close Formation Flying
	FRL	Fuselage Reference Line
	FOD	Foreign Object Damage
	g	Force of Gravity or Load Factor
	GA	Ground Attack
A	GSI	Glide Slope Indicator
	H	Hover
	HUD	Head Up Display
	HIFR	Helicopter In-Flight Refueling (ship to aircraft)
A	Hover Stop	The position of the nozzle lever which vectors the thrust to the vertical position (81 degrees).
	HSI	Horizontal Situation Indicator
	IAS	Indicated Air Speed
	IFR	(1) Instrument Flight Rules (2) In-Flight Refueling (aircraft-to-aircraft)
A	IMC	Instrument Meteorological Conditions
	IMN	Indicated Mach Number
A	INAS	Inertial Navigation Attack System
	JBD	Jet Blast Deflector
A	Jetborne Flight	Very slow speed flight supported by engine thrust only.
	JPT	Jet Pipe Temperature
A	JPTL	Jet Pipe Temperature Limiter
	LO	Loiter
A	LSO	Landing Signal Officer
	M	Mach number

M_D	Maximum permissible Mach number	
M_H	Maximum level flight Mach number	
M_M	Maximum operational Mach number, as defined by the maximum operational speed envelope.	
M_T	True Mach number	
MAT	Maximum Augmented Thrust	
MRP	Military Rated Power	
MRT	Military Rated Thrust	
MSL	Mean Sea Level	
N_f	Fan Speed	A
n	Normal load factor (in g units)	
n_y	Side load factor	
n_L	Maximum symmetrical flight limit load factor (i.e., the upper boundary of the design V_{-n} diagram).	
$-n_L$	Minimum symmetrical flight limit load factor (i.e., the lower boundary of the design V_{-n} diagram).	
NT	Non-terminal Transition	
NRT	Normal Rated Thrust	
NWS	Nosewheel Steering	A
OLS	Optical Landing System	
PA	Approach	
$\frac{pb}{2V}$	The helix angle described by a wing tip during a rolling maneuver, where: p = rate of roll about the body axis b = wing span, feet V = true airspeed feet per second	
PH	Precision Hover	
RC	Reconnaissance	
RCS	Reaction Control System (Variable exhaust ports at the extremities of the aircraft)	A
ROVL	Roll-On Vertical Landing	
RR	In-flight Refuel (Receiving)	
RT	In-flight Refuel (Tanker)	
RVL	Rolling Vertical Landing	A

RVTO	Rolling Vertical Takeoff
SAS	Stability Augmentation System
Semi-Jetborne Flight	Flight where lift is provided by a combination of engine thrust and wing lift.
SFC	Specific Fuel Consumption
SL	Short Landing (also Sea Level)
STO or ST	Short Takeoff
TAS	True Air Speed
TF	Terrain Following
TO	Takeoff
Transition	The maneuver of changing from nonconventional flight, wholly and partially jetborne, to conventional flight, or vice versa.
Trimback	Reduction of engine thrust and fan speed (N_f) by JPTL action.
TT	Terminal Transition
V	Velocity (time rate or linear motion in a given direction)
V_D	Maximum permissible speed as defined by the maximum permissible speed envelope.
V_{EAS}	Equivalent airspeed
V_E	Engaging speed in arresting operation
V_H	Maximum level flight speed
V_L	Limit speed parameter in basic configuration specified for structural design.
V_M	Maximum operational speed, as defined by the maximum operational speed envelope.
V_{NRP}	High speed, level flight, normal rated power
$V_{R/C}$	Speed for maximum rate of climb with normal rated power
V_S	Stalling speed
V_{SG}	Stalling speed in glide configuration
V_{SL}	Stalling speed in landing configuration
V_{SPA}	Stalling speed in power approach configuration
V_{STO}	Stalling speed in takeoff configuration
VFR	Visual Flight Rules

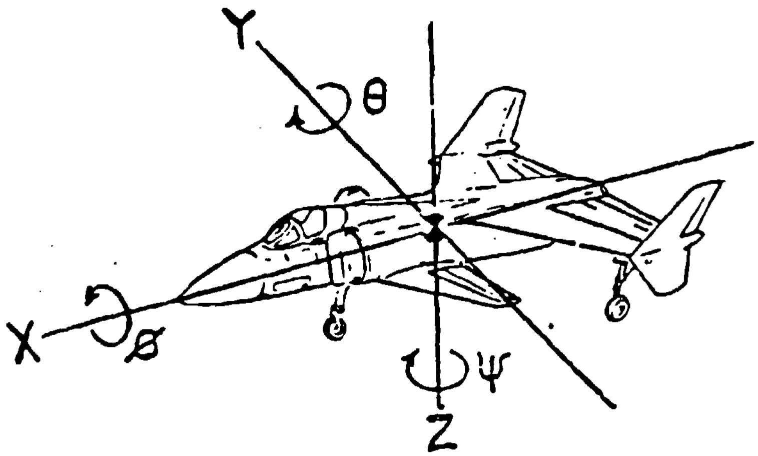
VL	**Vertical Landing**
VLA	**Vertical Landing Aids**
VTO	**Vertical Takeoff**
WO	**Waveoff**
WOD	**Wind over deck**

SPECIAL DEFINITIONS. - IYMP (Inertial Yawing Moment Parameter). The terms of IYMP, $I_x - I_y/mb^2$, are defined as follows:

I_x and I_y are airplane moments of inertia about the x and y axis, respectively ($slug\text{-}ft^2$); m is airplane mass (slugs); b is wing span (feet).

--CONVENTION--

ROTATION: YAW(β) FIRST, PITCH(α) SECOND



COORDINATES

SECTION I

AIRCRAFT DIMENSIONS, GENERAL ARRANGEMENT AND AIRCRAFT HANDLING

The data required in this section forms the basis from which determinations can be made regarding operational compatibility of specific aircraft with a specific ship or class of ship. This information, in conjunction with that of Section II, provides the information to determine deck loadings, operating and maintenance capabilities, aircraft handling procedures and timely identification of potential problem areas relative to safety and fleet readiness. A

*1. Aircraft Dimensions. One or more scale line drawings showing plan, elevation, front (and rear if applicable) views depicting all pertinent dimensions for folded, swept and spread configurations. In general the drawings shall conform to MIL-D-8706 (latest revision and addendum) paragraph 3.5.22(1) and include vertical dimensions from deck to all protuberances from the basic fuselage and from which all maximum and minimum dimension can be readily determined for spotting studies, elevator compatibility and include minimum size for transporting by aircraft or surface ship.

*2. General Arrangement Drawings. Several scale drawings and views that clearly depict and locate (Fuselage Station, Water Line and Butt Line) the following items: (Numbers in parentheses indicate appropriate paragraphs in MIL-D-8706.)

a. Centerline of all landing (alighting) gear (3.5.22(7)(a) (1), (2), (3)).

b. Towing Points, tow bars, steering bar, maximum and minimum nose steering angles, compatibility with SD-1 spotting dolly and M.L. aircraft handler type E.N./M.O.D. (Pt. No. G05551-500E), minimum turning radii and turn-over/tip-back angles with critical centers of gravity, and rearward motion with brake application (3.5.22(7)(a)(3) b., c. & d.). Submit any supporting evidence that shows the proposed aircraft will not tip back, turn over, or slip on the flight or hangar deck of all ship classes on which the proposed aircraft is intended to operate when subjected to the conditions stated in MIL-A-8863 and to the most severe ship motions and wind conditions encountered in upper sea state 5 (12.9 feet significant wave height).

c. Tie Down Arrangement including special provisions for High Power Turn-Up (3.5.22(7)(a)(4)). Is the high power turn-up compatible with the run-up anchor installation of the expeditionary airfield (NAEC Dwg No. 620543)?

A

d. Jacking Provisions (3.5.22(7)(a)(5).

e. Hoisting Provisions (3.5.22(3)&(6) and any special crash handling provisions.

*3. <u>Landing Gear</u>. This item shall include the requirements of 3.5.22(7)(b) and data/information on any automated securing devices associated with landing or moving the aircraft.

a. Shipboard Deck Strength. Provide information required in 3.5.18 as applicable with emphasis on aircraft sink speed limitations. Include similar information on nonconventional landing gear systems (e.g., outriggers).

A

*4. <u>Danger Areas</u>. Provide a series of drawings similar to Figures I-1 through I-8 that depicts the following:

NOTE

Indicate exit temperature and point of impingement where measurement of temperature and velocity is taken. Jet blast profiles shall be plotted to a distance (feet) of 250 feet; a decrease in exhaust temperature (°F) to 100°F, and/or a decrease in velocity (knots) to 35 knots. Plots shall be for no-wind or as specified.

a. Explosive Devices Danger Areas (Figure I-1)
b. Electro-Magnetic Radiation Danger Areas (Figure I-2)
c. Turbine Blade Failure Danger Areas (Figure I-3)
d. Inlet Suction (Plan View) for Idle RPM and MAT (Figure I-3)

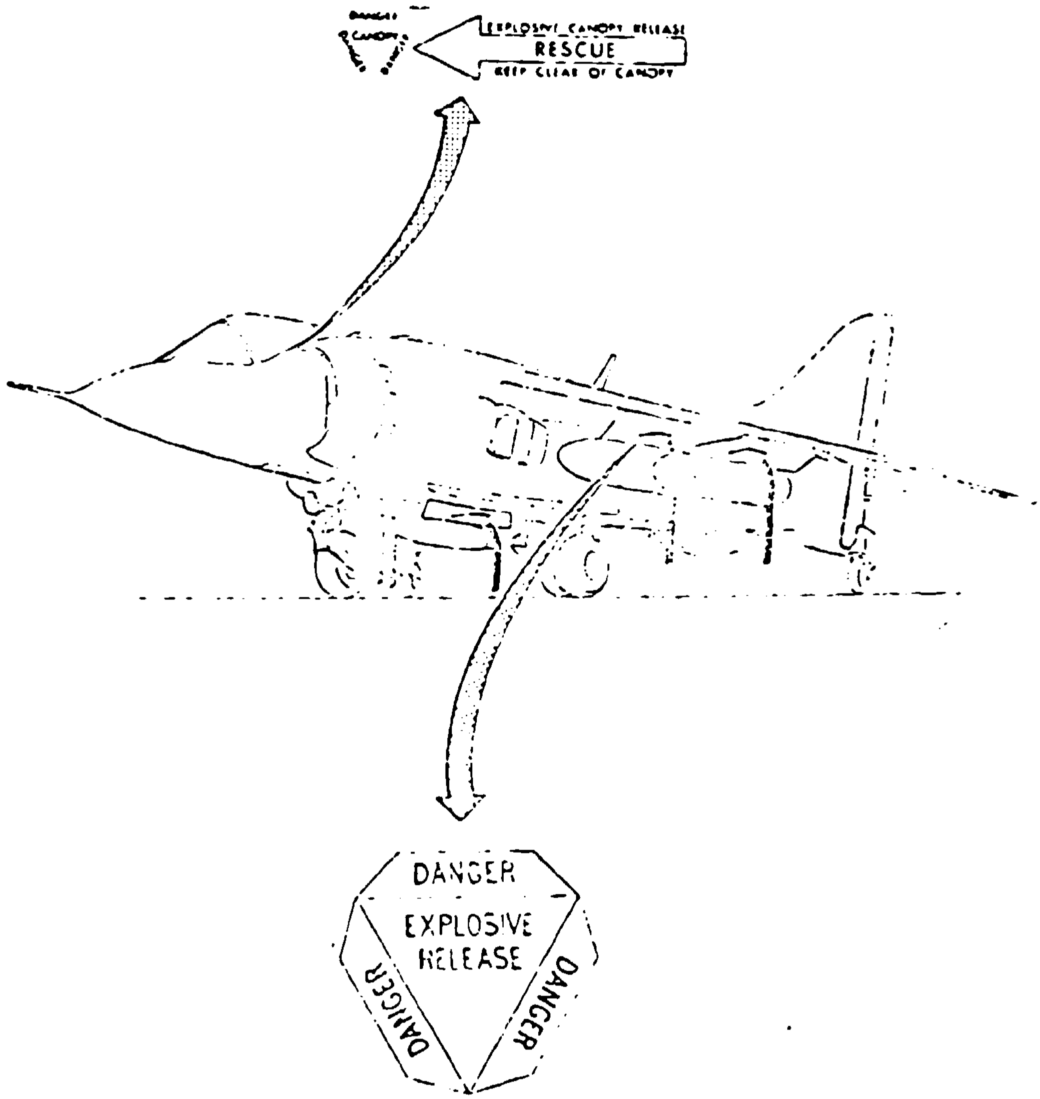


*Figure 1-1. Explosive Devices Danger Areas

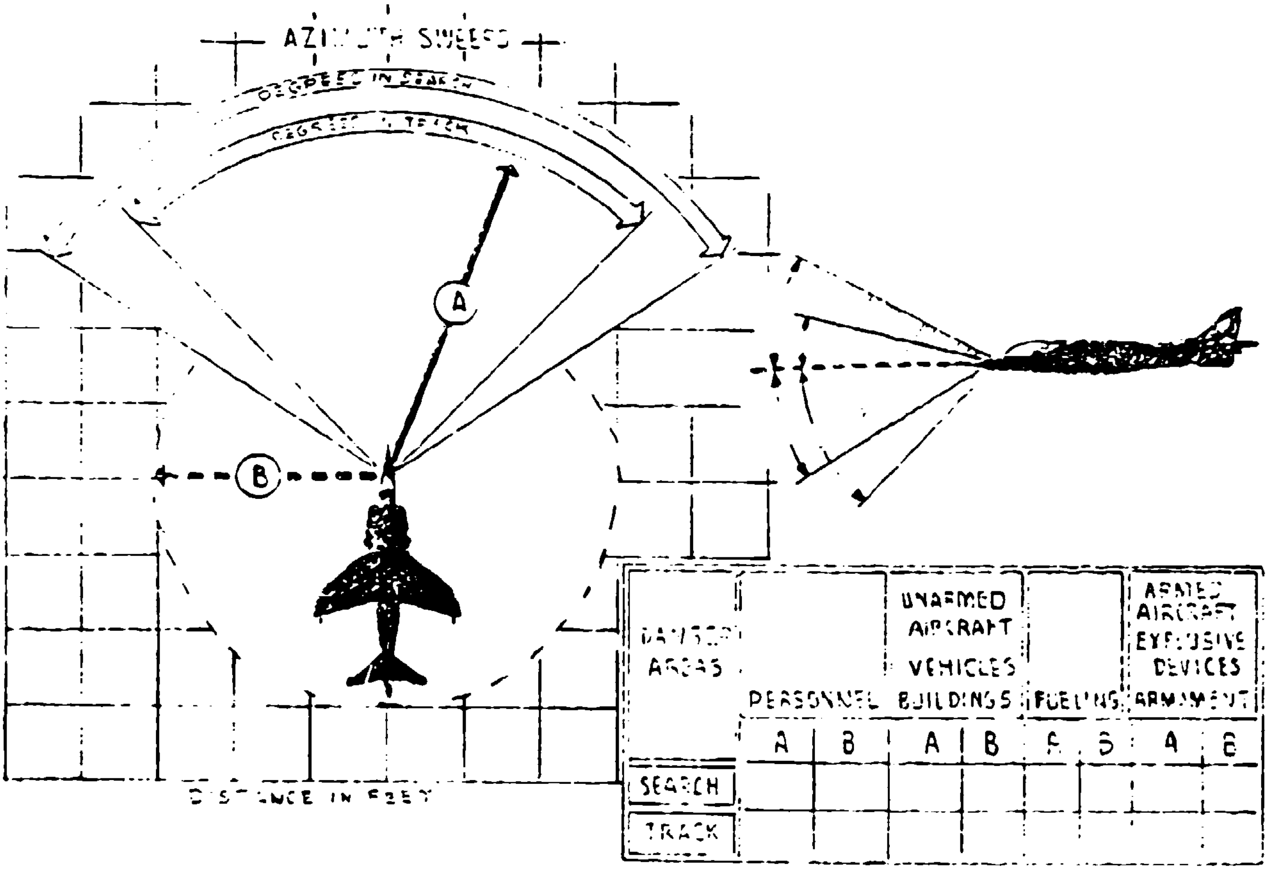


*Figure I-2. Electro-Magnetic Radiation Danger Areas

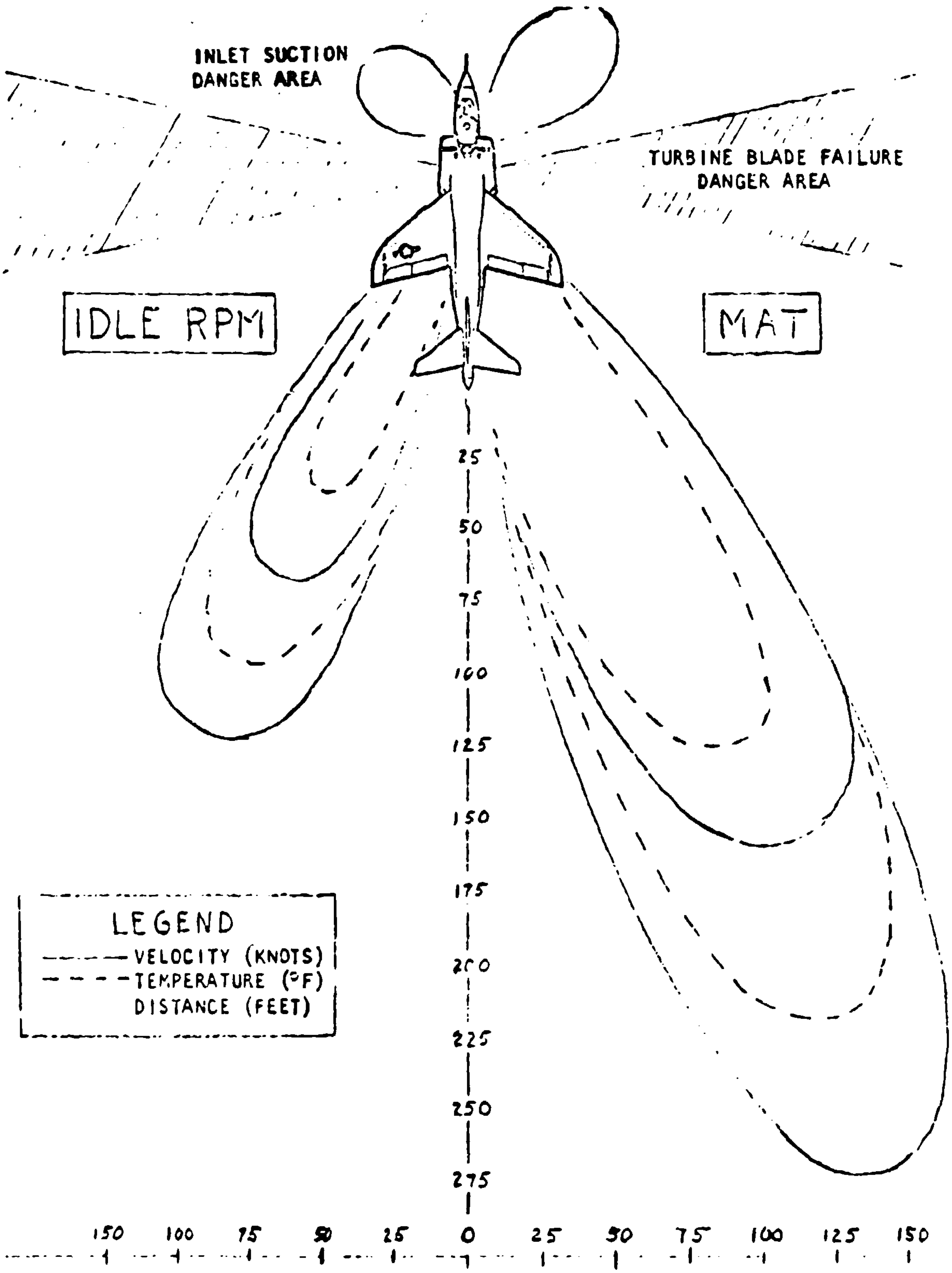


*Figure 1-3. Jet Blast & Personnel Danger Areas (Conventional/STO Mode)

e. Jet Blast/Vertical Lift Efflux and Reaction Control Profile (Figure I-4) for:

(1) Idle RPM

(2) MAT

(3) Variation in Profile Due to Thrust Angle Changes at MAT (Figures I-5a and I-5b)

(4) Vertical Profiles for Hover and VTOL with aircraft at altitudes of 0, 5, 10, 20, 30 and 50 feet and WOD at 0 and 30 knots (Figures I-6 and I-7).

f. Jet Blast Effects on Deck. What types of flight decks (e.g., material, thickness, coating) are not acceptable for operations with the proposed aircraft? What flight deck modifications will be necessary for safe operations? What are the maximum impingment temperatures of future engines for the proposed aircraft?

g. Exterior Acoustic Noise Level (Sound Pressure in Decibels (dBA) using the "A" weighted scale) Profiles from maximum down to 70 dBA for: (Figure I-8)

(1) Idle RPM

(2) MAT

(3) 20 Foot Hover

*5. Wind-over-Deck (WOD) Requirements and Limitations. Wind (knots) is considered to be from dead ahead of direction of takeoff except for crosswind and parking limitations. Minimum winds expressed as negative values (-) are considered tail winds. In addition to providing information in Figure I-9, depict headwind/crosswind limits on a 360° azimuth scale in a manner similar to Figure I-10. If an optimum wind exists for VTOL operations, so indicate. State any wind limitations on having cockpit canopy open for deck handling operations and for folding/spreading operations. Provide a plot of aircraft gross weight and takeoff distance vs WOD for STO similar to Figure I-11.

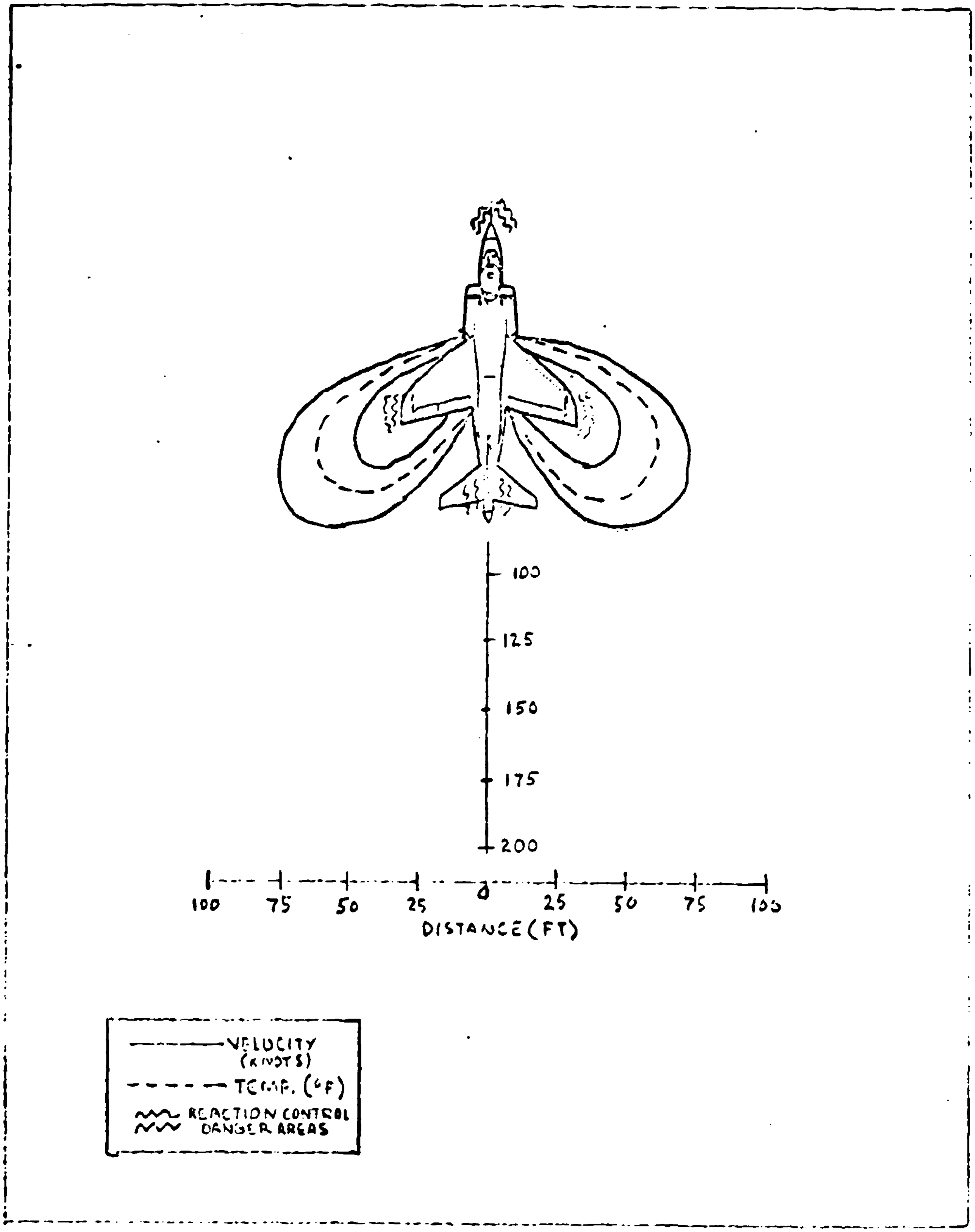


*Figure I-4. Jet Blast/Lift Effux Danger Areas (VTOL Mode) (Deck Level)

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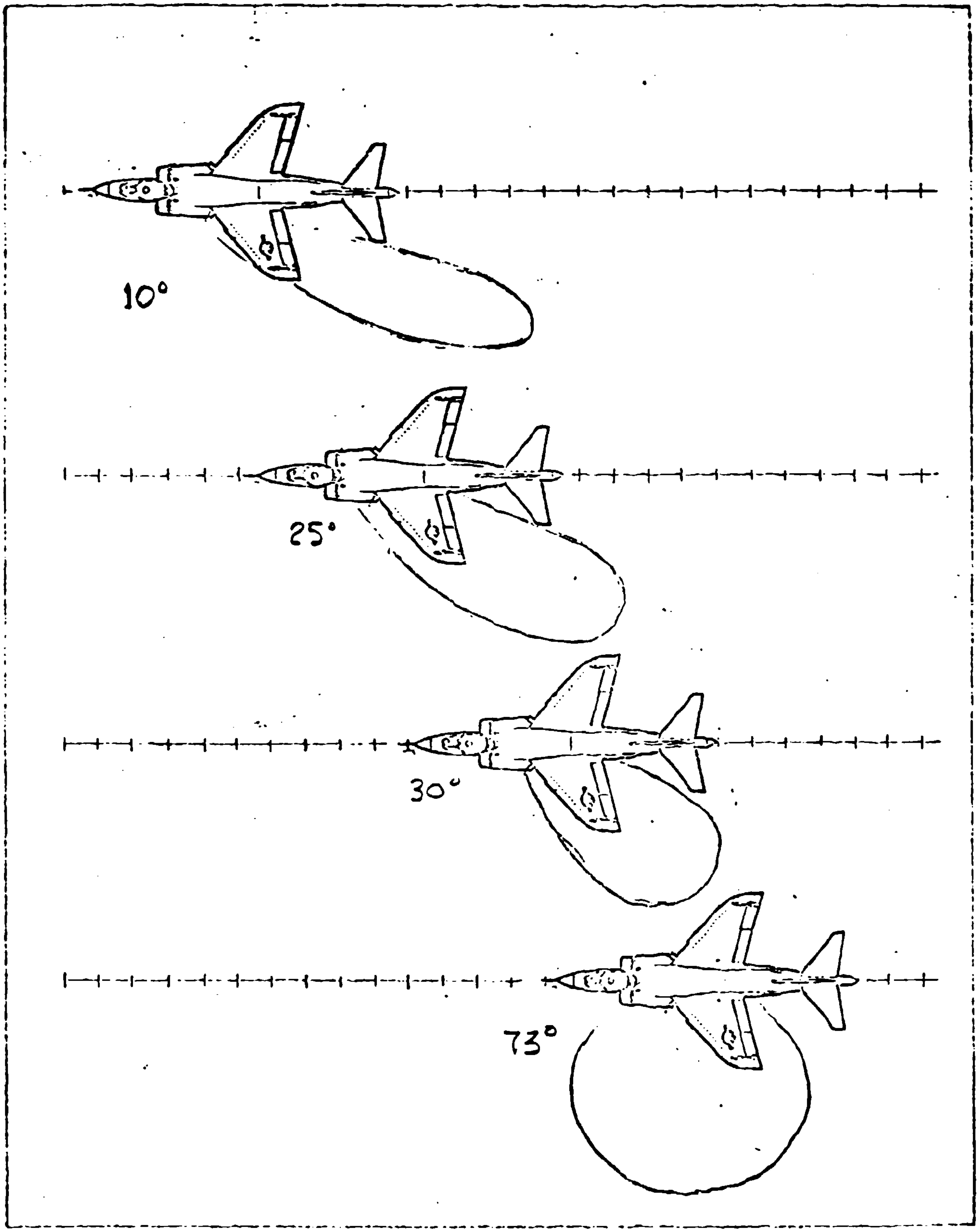

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*Figure I-5a. Blast/Effux Profile vs Thrust Angle Change
(Planview Profile; Deck Level)

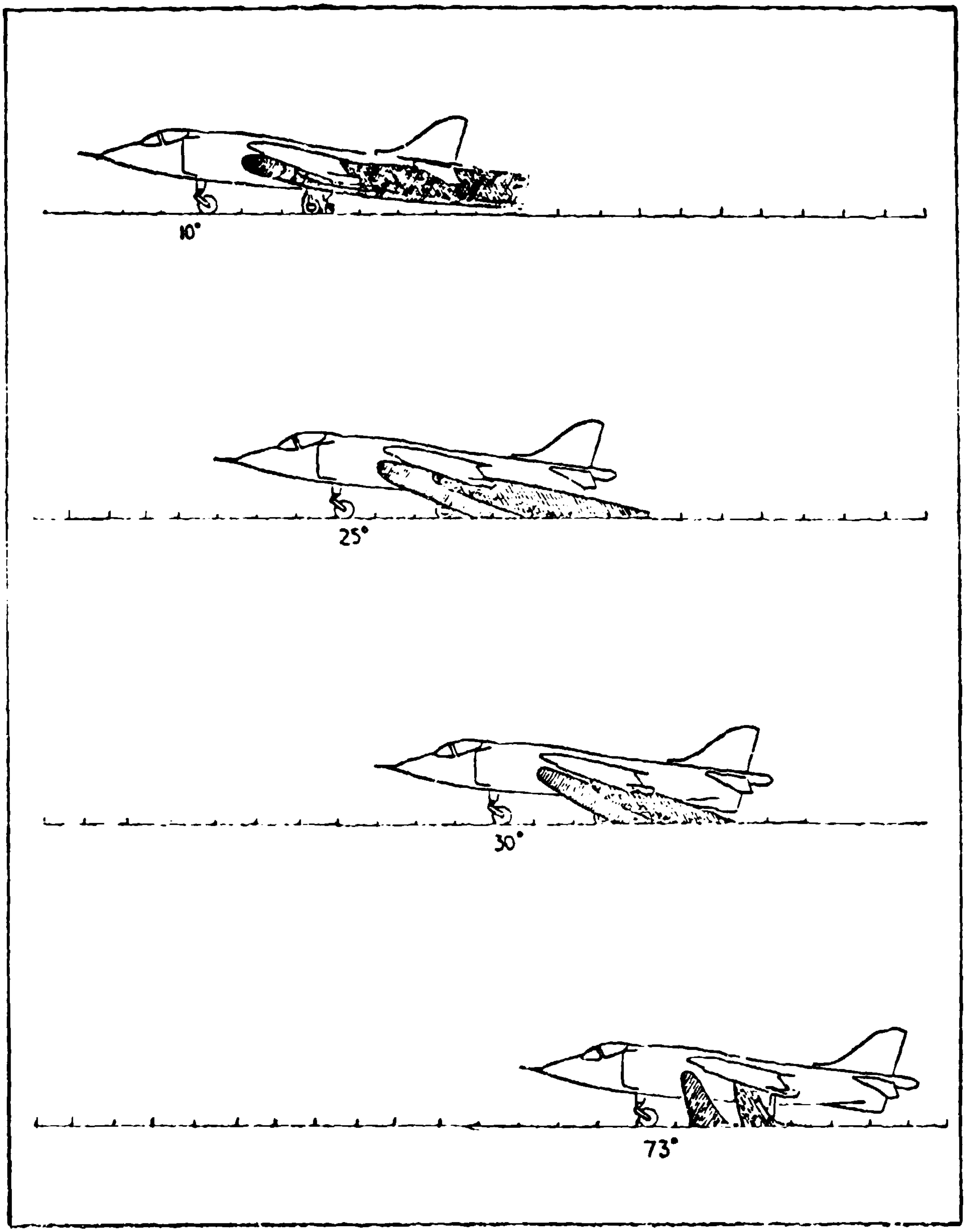

FIGURE I-5b, BLAST/EFFLUX PROFILE vs THRUST ANGLE CHANGE
OUTBOARD LEFT SIDE VIEW

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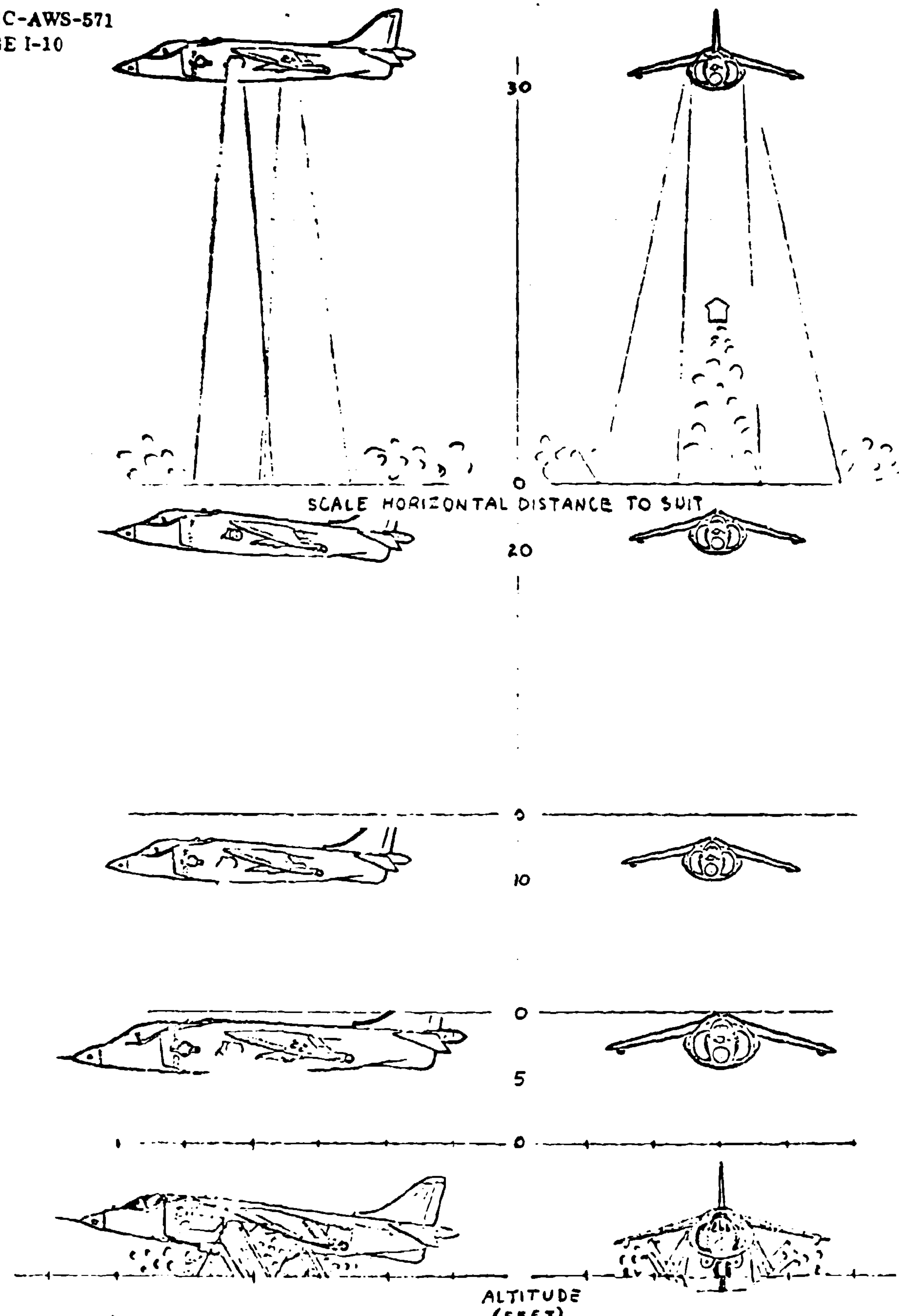


*Figure I-6 Vertical Profile of Blast/Efflux for VTOL (NO WIND)

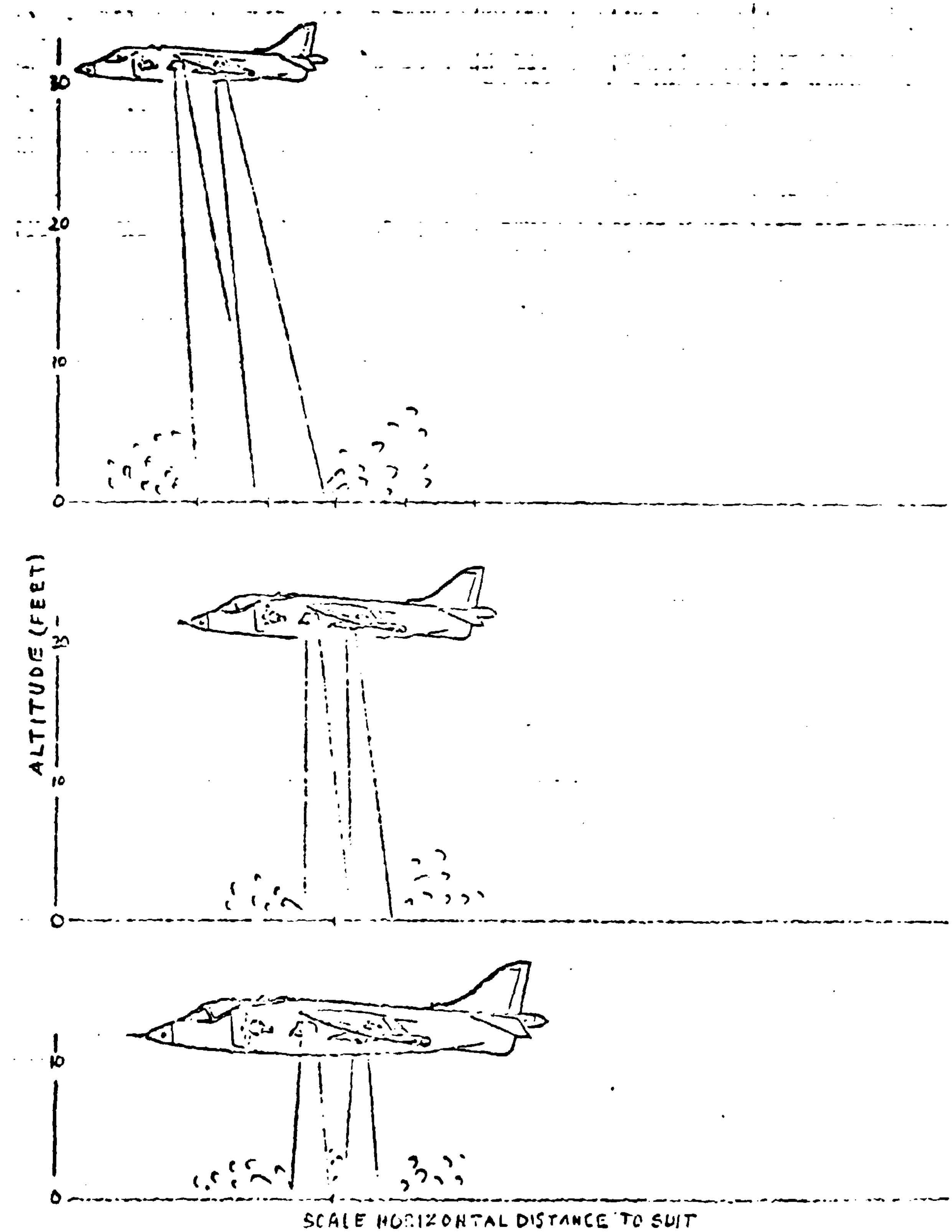


*Figure I-7. Vertical Profile of Blast/Efflux for VTOL (30 KNOTS WIND)

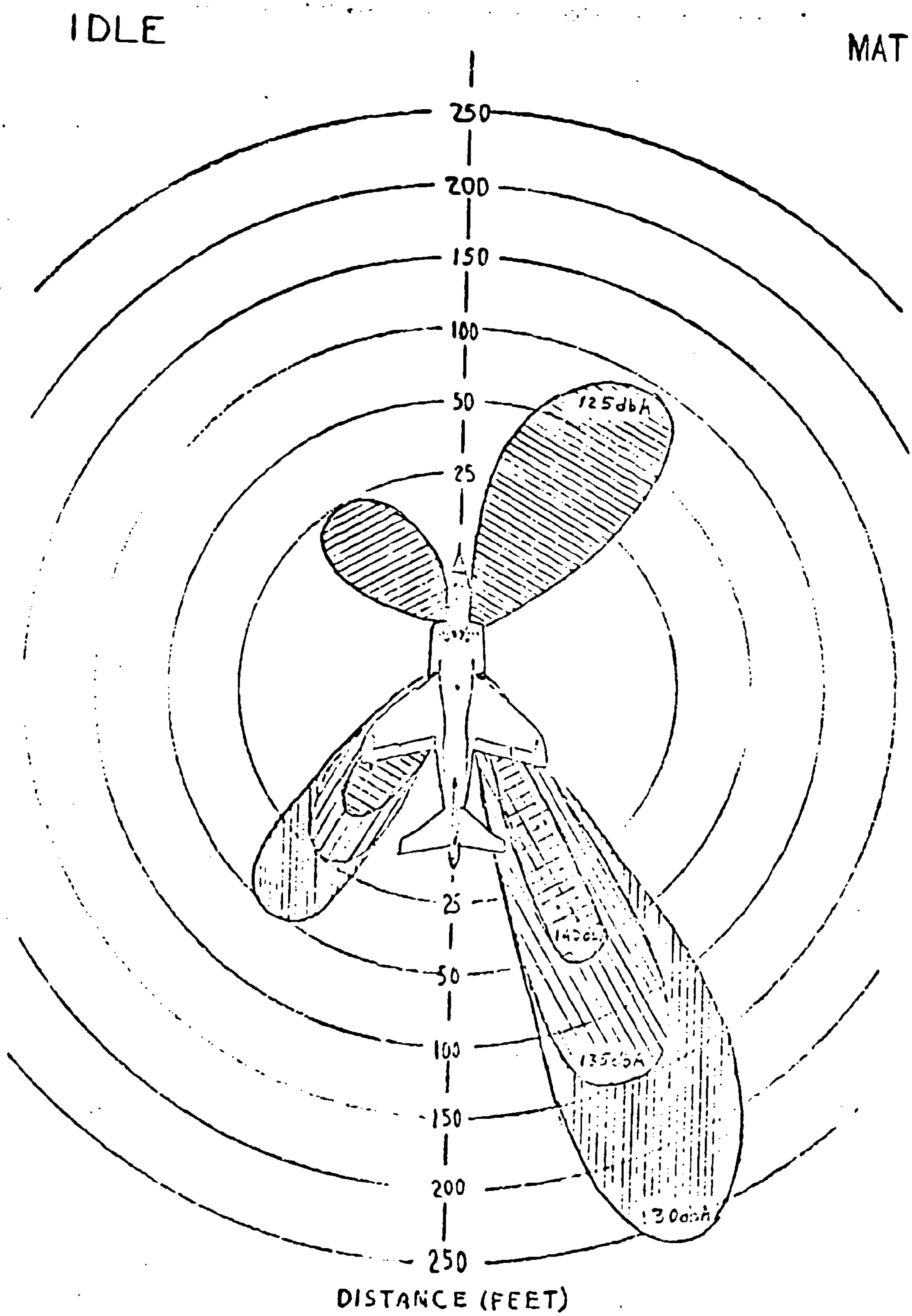


*Figure I-8. Noise Danger Areas

A/C Configuration	Moored	Catapult Max	Catapult Min	STO	VTO	Cross Wind	Arr Ldg	Vert Ldg	Short Ldg
Basic Weight		X	X	X	X		X	X	X
Mission Weight									
Max Gross									
1.2 x Design Gross									
Crosswind						X			
Single Engine	X								

Figure 1-9. Wind Limitations (Knots)

6. Blast Deflectors. Is the aircraft compatible with existing shipboard jet blast deflectors (JBD) (typically, 60° deflection relative to the flight deck)? Does a horizontal (deck grating) JBD system to diffuse blast/efflux protect personnel, enhance ground effects and alleviate or prevent jet efflux ingestion?

*7. Aircraft Turnaround Time. What is the time required from recovery to ready-to-launch? Include any evolutions or requirements in addition to the following:

a. Postflight Inspection

b. Refuel

c. Service (Lube, Lox, N_2 etc)

d. Weapons Load

e. Spotting

f. Preflight Inspection

g. Inertial Alignment

h. Start and Takeoff Checklist

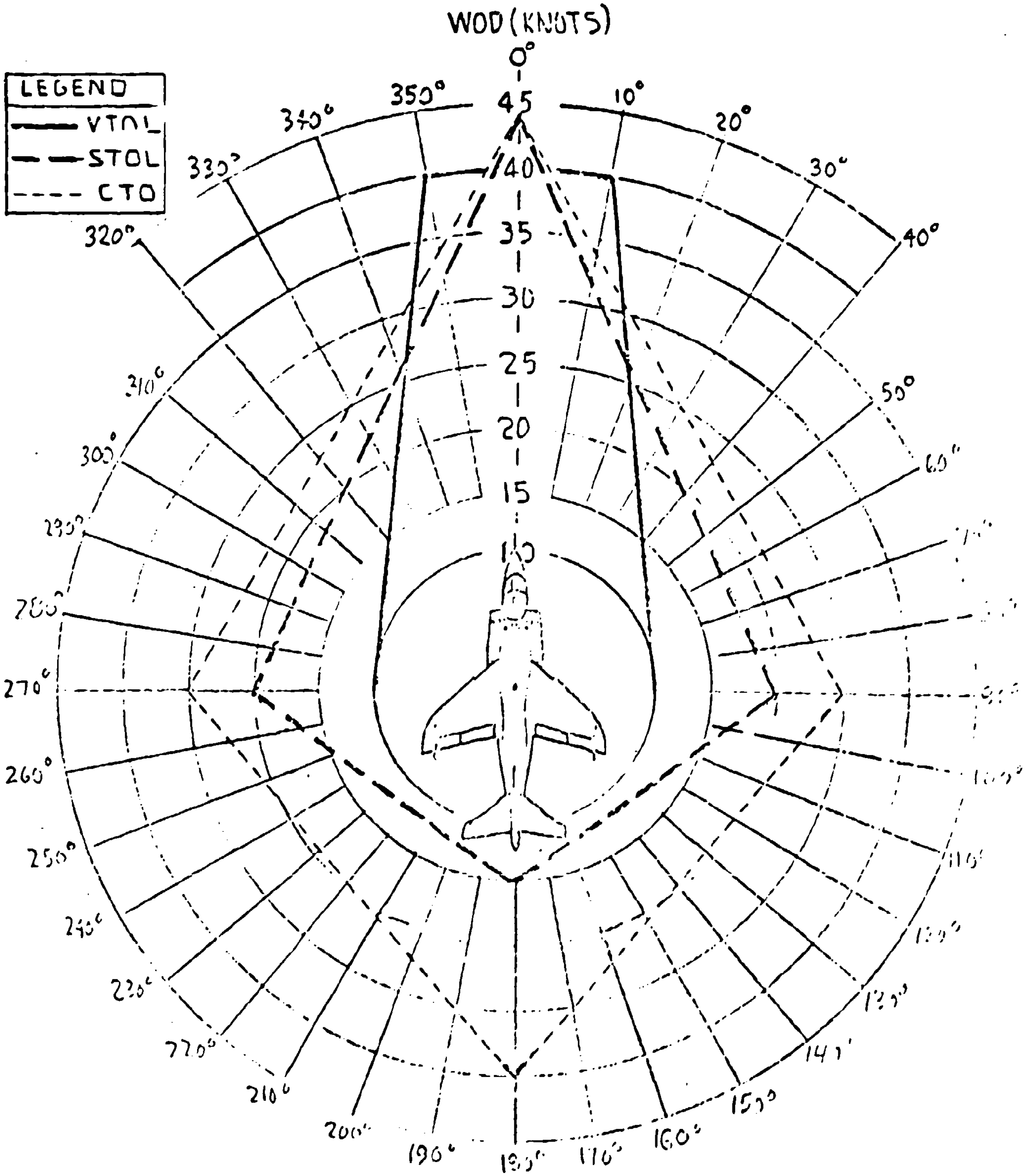


*Figure 1-10. WOD Limitations

REFLECTOR CURVE SHALL REPRESENT ICAO STANDARD DAY, MEAN LIFT/THRUST ENGINE(S) PERFORMANCE, AND LIFT/VECTORED THRUST ACTUATION SPEED.

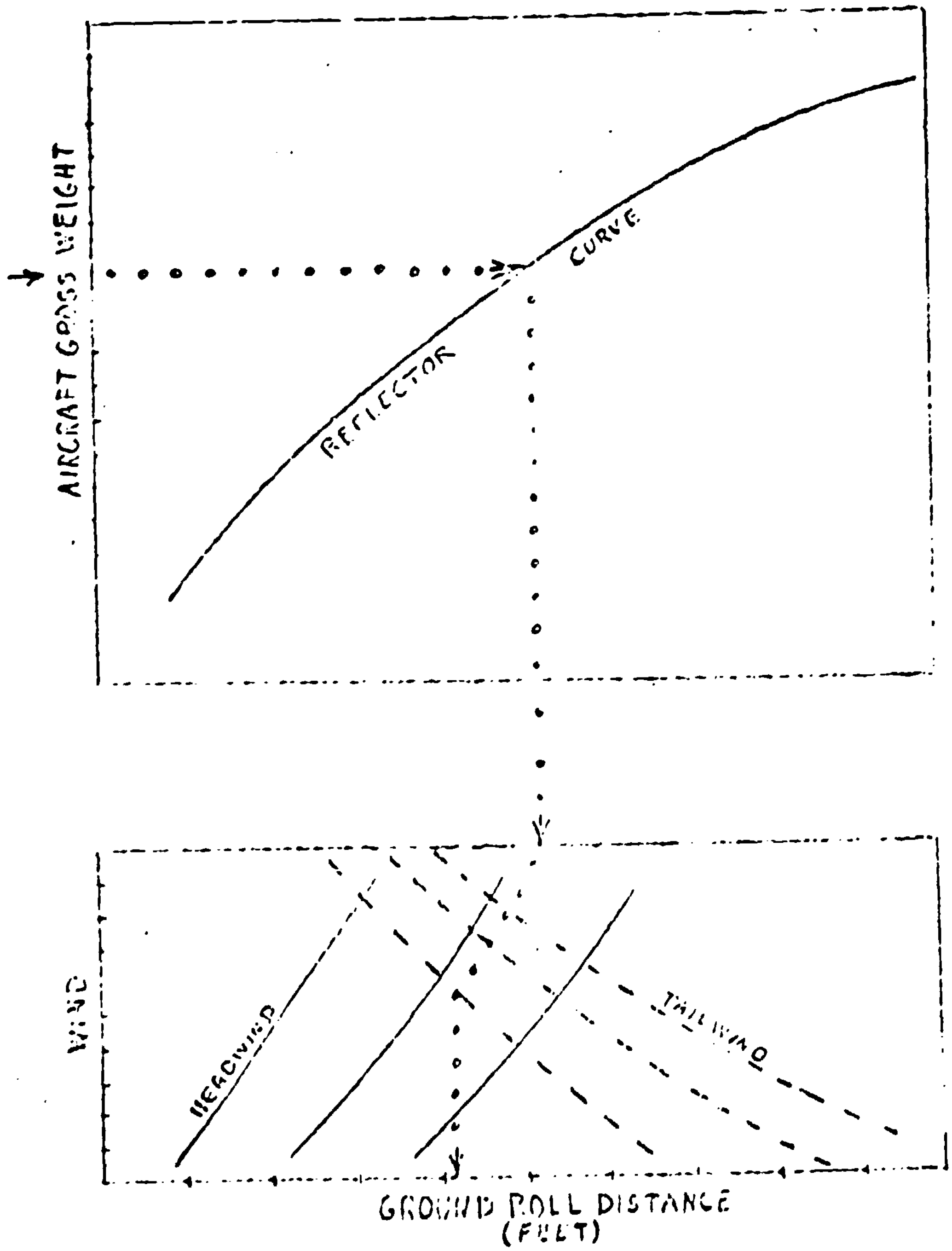


*Figure 1-11. STO Distance vs Wind Over Deck

Can tandem launches be safely executed? If yes, what is the minimum distance between aircraft (STO, VTO)? Should aircraft fuselage centerlines be offset?

8. Thrust Magnitude for Taxiing. What is the thrust magnitude (and thrust angle if applicable) required for initial movement and sustained taxi roll under conditions of 40-knot headwind and for wheel roll over 1-1/2 inch cable immediately after initial forward motion?

9. Planform Change. Indicate the time required and external power requirements to effect a complete cycle of folding (sweeping) and spreading all aircraft components capable of decreasing overall size for shipboard operations. Can planform change be accomplished with weapons/stores installed?

*10. Major Component Removal and Replacement. Specify the overhead, lateral or longitudinal clearance requirements and weight for removal of all major components (engines, wings, tail section etc.). Deck area clearances (sq. ft.) shall be specified for placement of components on racks, dollies or stands as well as special container sizes and volume for component stowage or shipment. Overhead clearances shall be measured from the throat of the hoisting hook to the bottom of the component being removed plus 6-inch clearance with the airframe.

a. Can component removal/replacement be accomplished (shipboard and shorebased) within the man-hours established in SD-24? What is minimum space required for engine, wing, component removal? Special equipment required?

b. What are the plans and procedures for composite material removal, inspection, repair, and storage (shipboard and shorebased)? Space required? Special equipment needed?

*11. Aircrew Visibility. Provide plan view and elevations depicting aircrew locations and visibility from aircrew stations. Pilot visibility shall be shown separately with aircraft in approach attitude and include rearward vision. Show visibility restrictions resulting from any planform change. (MIL-D-8706, 3.5.16 and MIL-STD-850).

*12. Communications. Is the aircraft equipped with ICS for cockpit to flight deck communications? If so, identify type.

13. State of the Aircraft (as defined in MIL-F-83300). The State of the aircraft is defined by the selected configuration together with the functional status of each of the aircraft components or systems, thrust magnitude, weight, moments of inertia, center-of-gravity position, and external store complement. The trim setting and the positions of the pitch, roll, and yaw controls are not included in the definition of Aircraft State since they are often specified in the requirements. The position of the thrust magnitude control shall not be considered an element of the Aircraft State when the thrust magnitude is specified in a requirement.

14. Aircraft Normal States. The contractor shall define and tabulate all pertinent items to describe the Aircraft Normal (no component or system failure) State(s) associated with each of the applicable Flight Phases. This tabulation shall be in the format and shall use the nomenclature shown in Table I. Certain items, such as weight, moments of inertia, center-of-gravity position, thrust magnitude and thrust angle control settings, may vary continuously over a range of values during a Flight Phase. The contractor shall replace this continuous variation by a limited number of values of the parameter in question which will be treated as specific States, and which include the most critical values and the extremes encountered during the Flight Phase in question.

15. Weapons Carrying Capability. What is the weapons carrying capability and arrangement of the proposed aircraft? Shipboard/shorebased?

*16. Mission Profiles. Submit four typical examples of potential mission profiles for shipboard use. They should include fighter, attack, ASW, and reconnaissance missions, if appropriate. Parameters to be defined are loadings, fuel weights/consumption, distances, times, altitudes, and average Mach number.

*17. Operating Platforms. Table II contains a list of ships (and their characteristics) on which the proposed aircraft may operate. Identify any problems that may be encountered or reasons why they are not compatible. State any ship alterations that may be required to

TABLE I. AIRCRAFT NORMAL STATES

Flight Phase		Weight	CG	External Stores	Thrust Magnitude	Thrust Angle	High Lift Devices	Wing Sweep	Wing Incidence	Landing Gear	Speed Brakes	Bomb Bay or Cargo Doors	Stability Augmentation	Other
		Pounds x 100	% MAC	Coded	Pounds x 100	∠°	Extend Retract On/Off	∠°	Up/Down ∠°	Up Down	Out In	Open Closed	On/Off	
Vertical Takeoff	VT													
Short Takeoff	ST													
Hover	H													
Precision Hover	PH													
Climb	CL													
Cruise	CR													
Loiter	LO													
Descent	D													
Emergency Descent	ED													
Emergency Deceleration	DE													
Non-terminal Transition	NT													
Terminal Transition	TT													
Approach	PA													
Wave-off/Go-around	WO													
Vertical Landing	VL													
Short Landing	SL													
Air-to-air Combat	CO													
Ground Attack	GA													
Weapon Delivery/Launch	WD													
Aerial Delivery	AD													
Aerial Recovery	AR													
Reconnaissance	RC													
In-flight Refuel (Receiver)	RR													
In-flight Refuel (Tanker)	RT													
Terrain Following	TF													
Antisubmarine Search	AS													
Close Formation Flying	FF													

TABLE II. SHIP DIMENSIONAL DATA

	FLIGHT DECK			HANGAR DECK			ELEVATORS			HANGAR DOOR OPENING		FULL LOAD DISPLACEMENT	DECK LOADING
SHIP CLASS	Length (ft-in.)	Width (ft-in.)	Free-board (ft-in.)	Length (ft-in.)	Width (ft-in.)	Height (ft-in.)	Length (ft-in.)	Width (ft-in.)	Capacity (lb)	Width (ft-in.)	Height (ft-in.)	(tons)	Parking (lb)
CVN-68	1077	239	62-08	684-00	110-00	25-00	70-00	52-00	130,000	70-00	25-00	91,400	90,000
CV-59	1017	238	62-03	740-00	107-00	25-00	63-00	52-00	79,000	63-00	25-00	79,650	59,600
CV-43	954	193	52	692-00	90-00	17-06	56	44	74,000	63-00	17-06	63,400	70,000
AOE-1	73-07	56-00	30-00	48-09	55-00	19-02	N/A	N/A	N/A	18-00	19-02	52,483	
AOR-1	102-05	55-06	40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	41,350	
LHA-1	820	68-00	64-06	266-00	78-00	20-00 23-06	50-00 59-08	34-00 34-08	40,000 80,000	34-09 34-00	20-00 23-06	30,300	58,000
LPH-2	592-00	55-00	50-00	288-00	80-00	20-00	50-00	34-00	35,000 50,000	19-00	21-00	18,000	42,000
AE-21	74-04		32-00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17,150	
LCC-19	98-08	74-01	45-00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17,100	58,000
LPD-4	223-06	75-10	34-06	58-00	18-07	18-00	N/A	N/A	N/A	20-05	17-10	17,000	42,000
CSGN MK 1	82-00	75-00	28-00	64-00	35-00	19-06	N/A	N/A	N/A	32-00	19-00	17,000	40,000
LSD-36	85-06	72-04	35-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13,700	70,000
DDG-47	70-00	42-00	29-05	46-00	28-00	15-00	N/A	N/A	N/A	30-06	15-03	9,500	48,000
DD-963	70-00	41-11	31-06	46-00	20-03 23-00	17-03	N/A	N/A	N/A	23-11	17-10	7,600	45,000

NOTE

The information contained in this table is representative of the ships in the classes shown. Specific data on any particular ship in the class should be obtained from other sources.

reduce the areas of incompatibility. Are there any restrictions on the use of ship's weapons systems during flight operations? What are deck motion limits for V/STOL operations? (For more detailed information see NAVAIR SI Chart No. 1134A, NAEC 06900 and NAEC-ENG 7576.

*18. Mixed Operations. The proposed aircraft may be required to participate in simultaneous shipboard operations with conventional aircraft. Define areas where the scenario will limit the proposed aircraft's operating capability (e.g., takeoffs or landings aft of a conventional aircraft turning up on a catapult). State optimum simultaneous operating techniques for Figure 1-12 (e.g., takeoff and landing areas, approach paths). What limitations exist for flight operations/deck handling with respect to arresting gear wires? (For detailed CV characteristics see NAEC 06900, latest revision).

*19. Deck Edge Effects, Angled Deck Limitations, and Clearances. What effect will ship-induced turbulence at the deck edge have on V/STOL operations? What is the minimum allowable wingtip (/outrigger) to deck edge clearance? What is the minimum allowable wingtip (/outrigger) to obstacle clearance? What is the minimum area required for VTOL? What is the minimum angle (β) a STO centerline may make with a deck edge and still be acceptable for full operational use (see Figure 1-13)? What is the minimum required ship freeboard height (flight deck to draft water line) for continuous flight operations? Emergency flight operations?

A

*20. Spotting Factors

a. LPH-2.

(1) Assume all aircraft are fixed-wing V/STOL.

(a) What is the maximum number of aircraft that can be safely spotted for VTO on the flight deck?

(b) What is the maximum number of aircraft that can be safely spotted for STO launch?

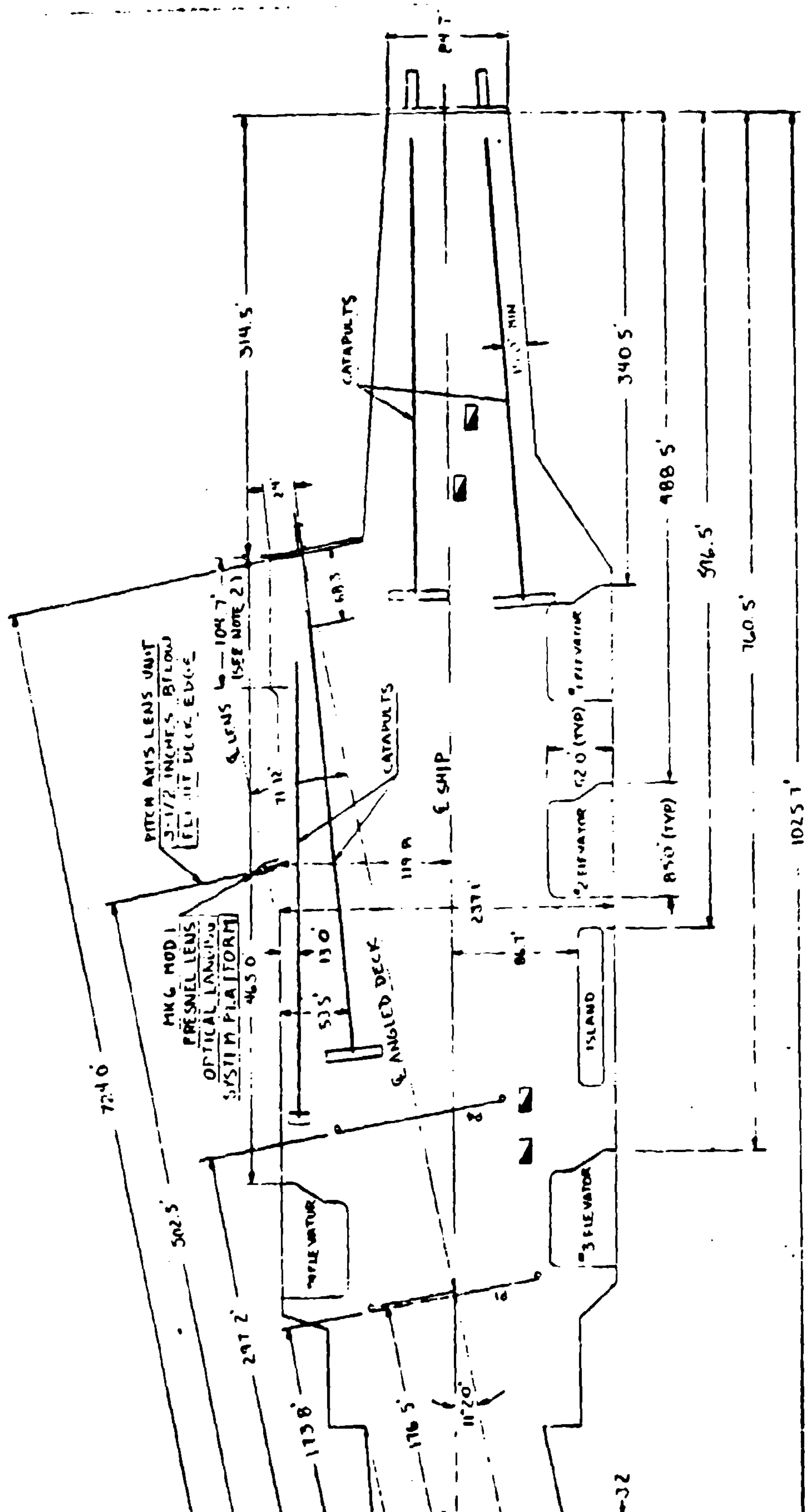
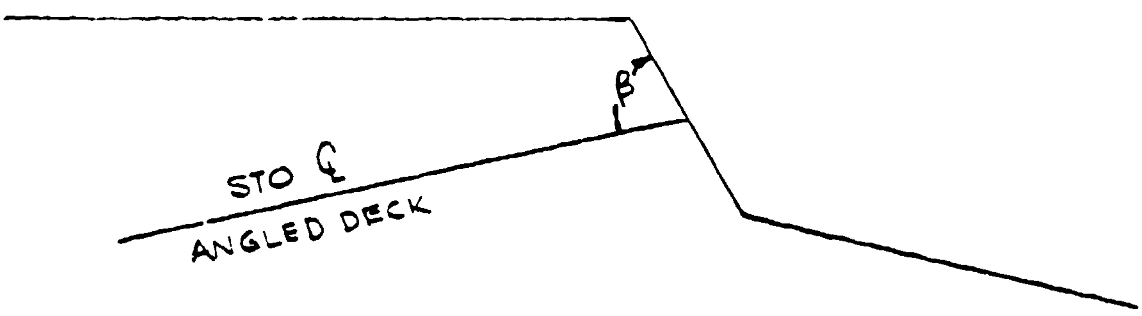


Figure 1-12. Conventional/V/STOL Aircraft Typical Simultaneous Operating Environment

A



A

Figure 1-13. Angled Deck Edge Characteristics

(2) Assume 50% of aircraft are fixed-wing V/STOL and 50% are helicopters (SH-2F).

(a) What is the maximum number of aircraft that can be safely spotted for a mixed launch in the VTO mode?

(b) What is the maximum number of aircraft that can be safely spotted for launch in the STO mode?

b. CV-60

(1) Assume that all aircraft are VTOL.

(a) What is the maximum number of aircraft that can be safely spotted for launch in the VTO mode?

(b) What is the maximum number of aircraft that can be safely spotted for launch in the STO mode?

(2) Assume 30% of the aircraft are VTOL and 70% are conventional.

(a) What is the maximum number of aircraft that can be safely spotted for launch in the VTO mode?

(b) What is the maximum number of aircraft that can be safely spotted for launch in the STO mode?

*21. Compatibility with Ship's Elevators. Is the proposed aircraft with wings folded/swept compatible with the elevator sizes listed in Table II with a minimum clearance of 18 inches about the periphery of the aircraft when parked on the elevator with the aircraft centered and nose pointed inboard (deck edge elevator) or nose aft (centerline elevator)? When the aircraft is parked diagonally and centered on the elevator? Is the aircraft maximum gross weight within the capacity of the elevator?

SECTION II

LAUNCH AND RECOVERY INFORMATION

AIRCRAFT PERFORMANCE AND LIMITATIONS

Data required in this section provides the essential information to determine ship/aircraft capabilities with respect to takeoff and landing requirements and the aircraft limitations that influence mission capabilities and operational cycle times.

1. Engine Operating Limitations. Identify the engine(s) and tabulate operating limitations for various engine ratings (Starting, Idle, Max Continuous etc.) in a manner similar to the example shown in Figure II-1. Limitations shall be based on standard day at sea level. Indicate any special requirements for cooling (blow through) prior to engine(s) shut down.

ENGINE OPERATION	TURBINE INLET TEMPERATURE (Maximum)	ENGINE SPEED (rpm)	OTHER LIMITS	OPERATING TIME LIMIT
Starting				
Idle				
Normal				
Military				
Acceleration				
Other				

Figure II-1. Engine Operating Limitations

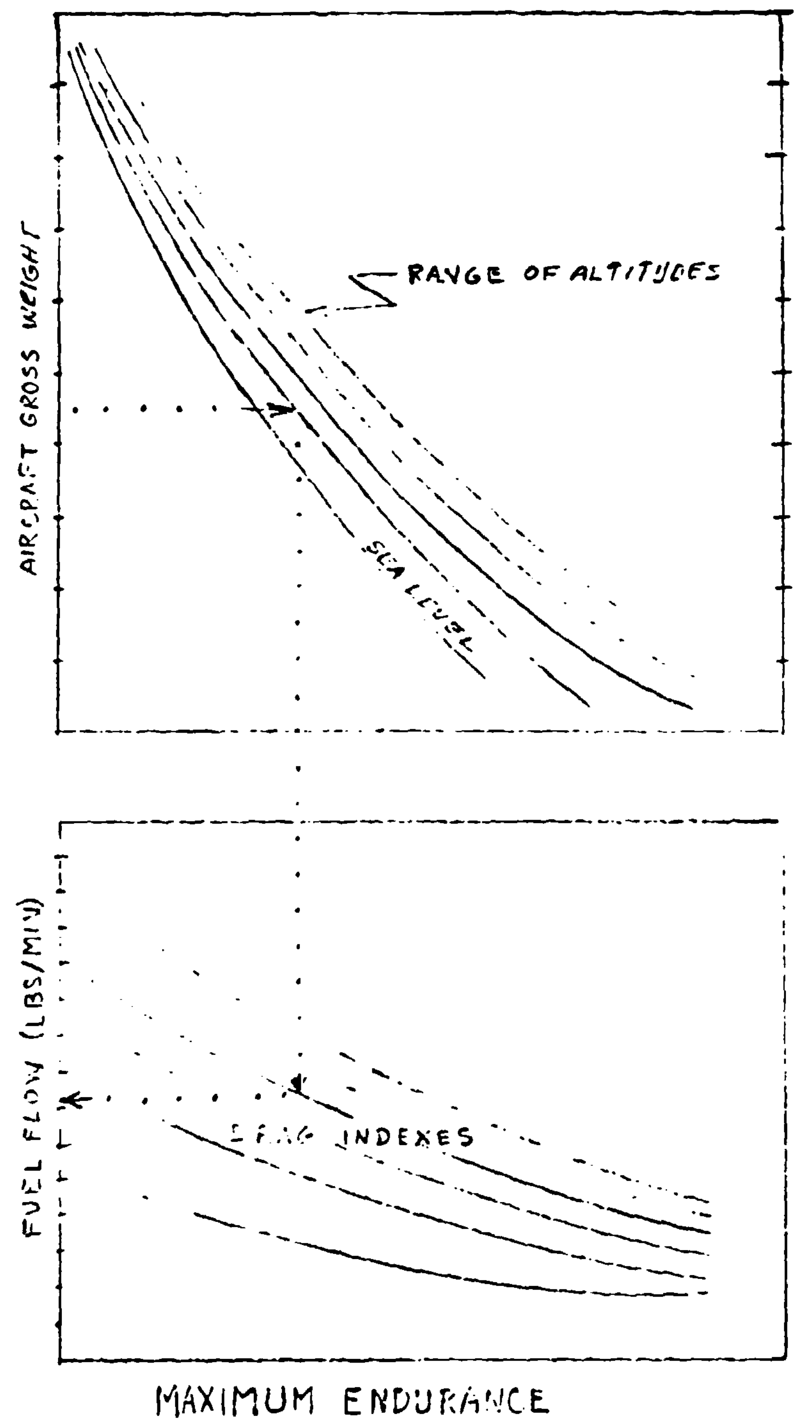
*2. Fuel Consumption. Indicate by curve plots or tabulate the Fuel Flow (lbs/min) as a function of Gross Weight, Altitude, Drag Configuration and Mach number for the following Flight Phases. Specify the type fuel, engine(s) and data basis for ICAO standard day. Identify data as Figure II-2 series.

a. Maximum Endurance

b. VTO

c. STO

d. VL



VTO	STO	VL

FUEL FLOW vs WT.

Figure II-2. Fuel Consumption

*3. Thrust Variation. Plot the total engine(s) thrust variation due to ambient temperature, density altitude aircraft velocity and ground effect (0 to 6 ft. above deck). (Figure II-3 and II-4). Define situations in which reingestion (near/far field) and ground/fountain effects will cause a loss of performance or operational capability. A

4. Aerodynamic Data. Provide aerodynamic drag information expressed as drag coefficients, indices, or contractor established numbers, as required by MIL-D-8706 (3.5.3.1(1), (2), and (4). (Figure II-5) A

*5. Stability and Control. Provide information required by MIL-D-8706 (3.5.2.3) that directly pertains to VTO, STO and VL for various aircraft configurations and loadings up to maximum gross. All external loading configurations that influence stability and control shall be indicated as well as effects of ship motion and ship generated turbulence in the takeoff and landing areas of the deck. Emphasis shall be placed on ground effect and the abrupt loss or gain thereof as the aircraft departs the flight deck in STO mode, and in the landing approach.

6. Moments of Inertia. Provide moment and product of inertia data from the requirements of MIL-D-8706 (3.5.2.3) and MIL-F-83300 (3.1.3). (Figure II-6)

7. Single Engine Operation. Does the aircraft have a single engine launch/recovery capability in the event a failure occurs in Lift Engine(s) or Thrust Engine(s)? Discuss any limiting factors such as increased WOD requirements or degradation in stability control.

8. Vertical Flight Regime. The method of achieving VTOL or the ability to hover shall be explained to clarify any unique parameters that are utilized in calculating or determining the efficiency or capability of the aircraft. Examples are the use of Takeoff and Landing Weight Ratios, Drag Numbers or Indices, etc.

*9. Vertical Takeoff Capability. Provide a plot of curves to depict VTO as a function of various aircraft gross weights, configurations, ambient temperatures, density altitudes and WOD. Include brief description of pilot technique and explain any advantages of Rolling

Engine Thrust Required & Available Vs Aircraft Velocity At Various Take-Off Weights

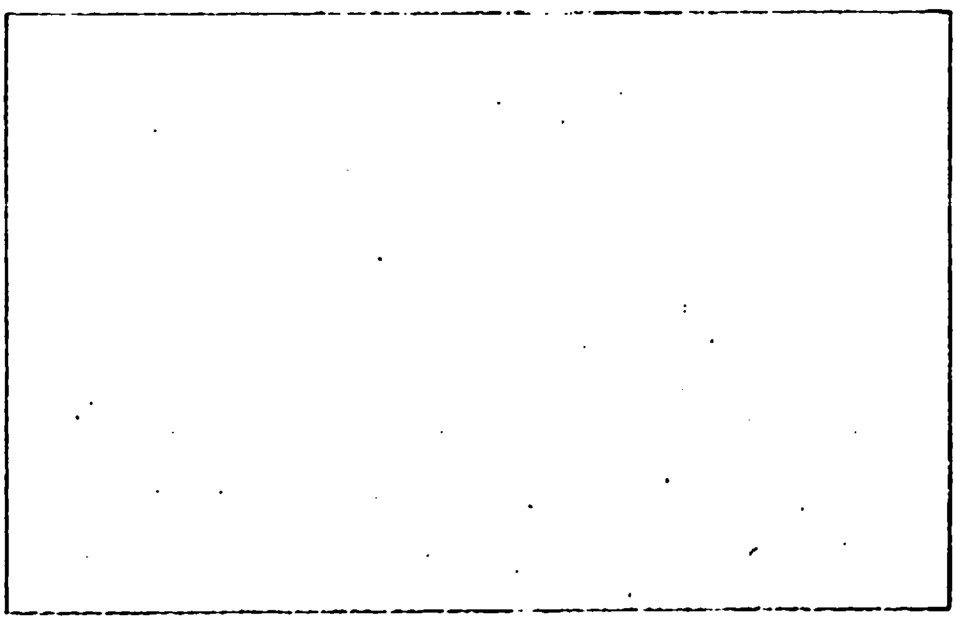


Figure II-3

Thrust Variation Due To Temperature And Velocity

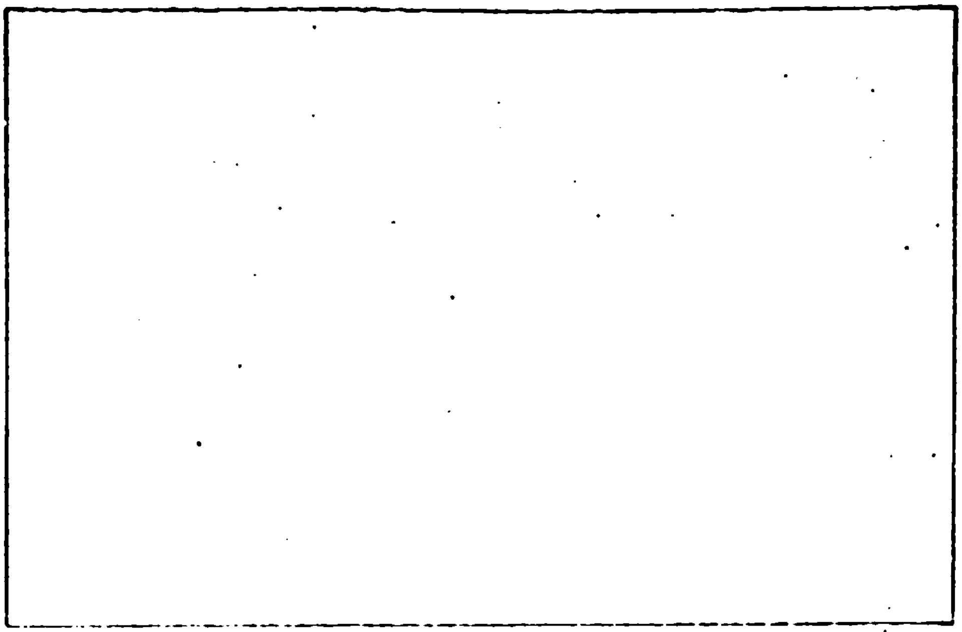


Figure II-4

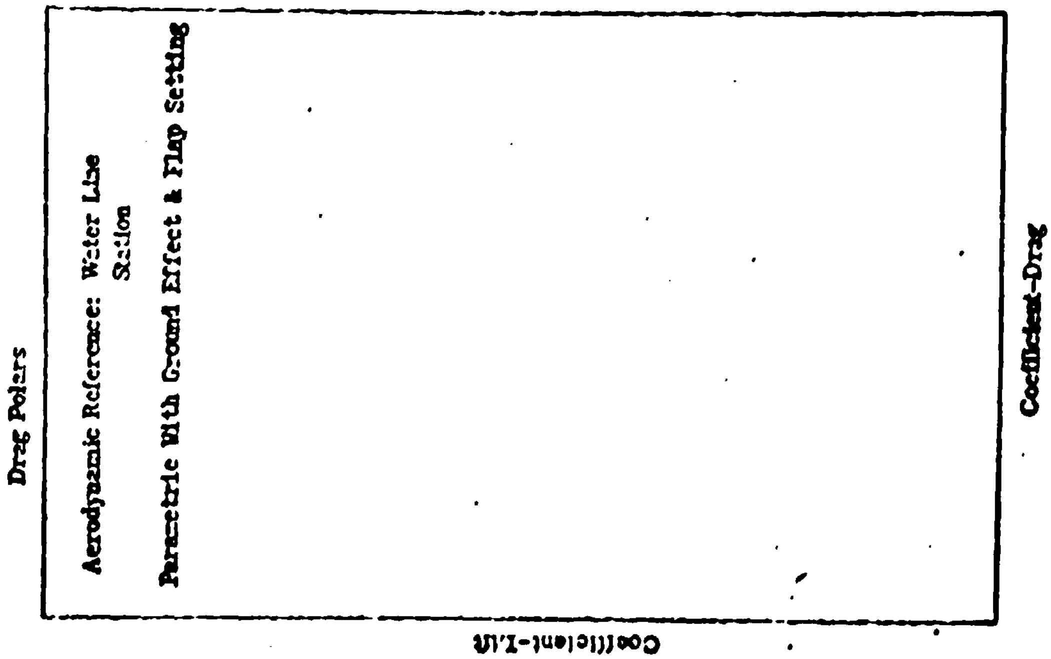


Figure II-5

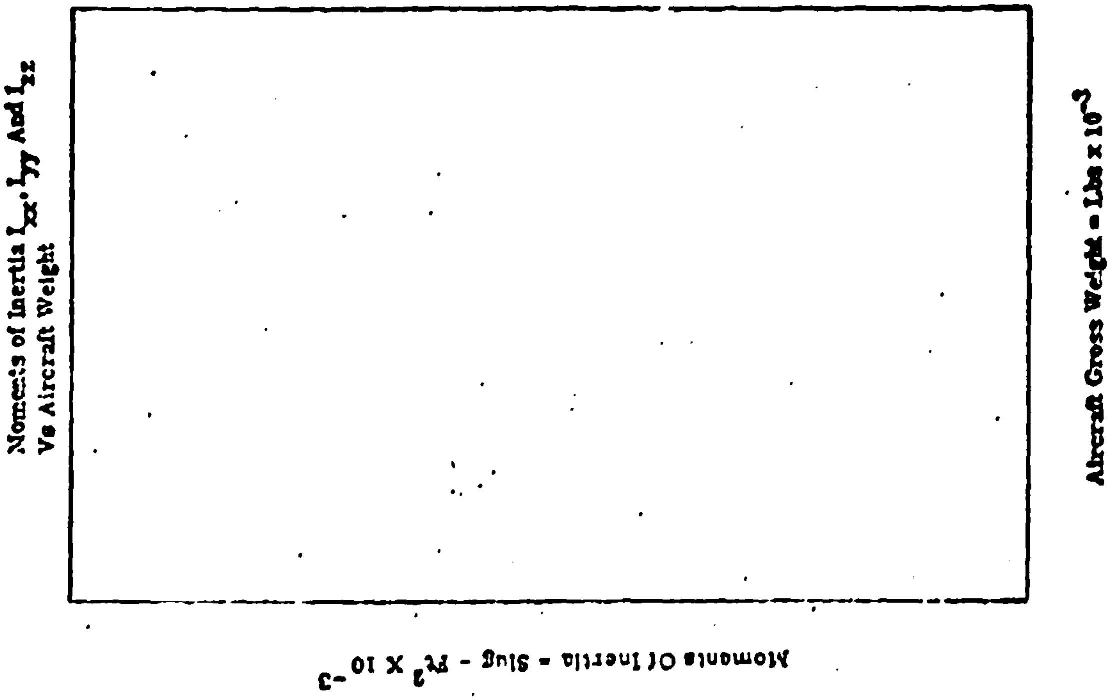


Figure II-6

A Vertical Takeoff (RVTO) versus VTO. (Figure II-7 series) What is optimum WOD for VTO? Is the aircraft capable of a VTO with no wind on a 90° day? What are the weather minimums? What is the time required for VTO at maximum hover weight to attain an altitude of 20 feet?

10. Transition. Provide the time required to accomplish VTO and transition to aerodynamic flight for various aircraft configurations with no wind on standard day. Additionally, give the time required for transition, hover and landing.

*11. Short Takeoff (STO) Distance. Plot the required takeoff distance for STO as a function of aircraft gross weight, aircraft configuration, ambient temperature, density altitude, thrust magnitude, thrust angle and WOD. Provide additional plots or information regarding critical trim settings that influence STO or pilot technique and airborne distance to clear a 50-foot obstacle. Indicate the basis of data presented and identify as Figure II-8 (series). What is the average payload increase over and above maximum gross weight that can be safely achieved for each 50-foot increase in deck run? What is the average payload increase that can be safely achieved for each 5-knot increase in WOD (span 0 to 45 knots)? What are the weather minimums for STO? State the recommended pilot technique and procedures. Provide headwind, crosswind, and tailwind limits. Is an operable HUD and SAS required for STO? Identify the minimum recommended clearances. Is the proposed aircraft equipped with a radar altimeter? What is the nozzle rotation rate, if appropriate? Is the proposed aircraft compatible with the British Ski Jump? If not, what modifications to the aircraft would be required?

12. Conventional Takeoff (CTO) Distance. Plot the required distance for CTO as a function of gross weight, aircraft configuration, ambient temperature, density altitude, thrust magnitude and WOD. Include data basis, aircraft limitations and airborne distance to clear a 50 foot obstacle (Figure II-9). Discuss refusal speed, abort techniques and plot refusal speed as function of ambient temperature, pressure altitude, gross weight and runway length with zero WOD.

A *13. Vertical Landing Capability. Provide a plot of curves (similar to Figure II-7) to depict VTO as a function of various aircraft gross weights, configurations, ambient

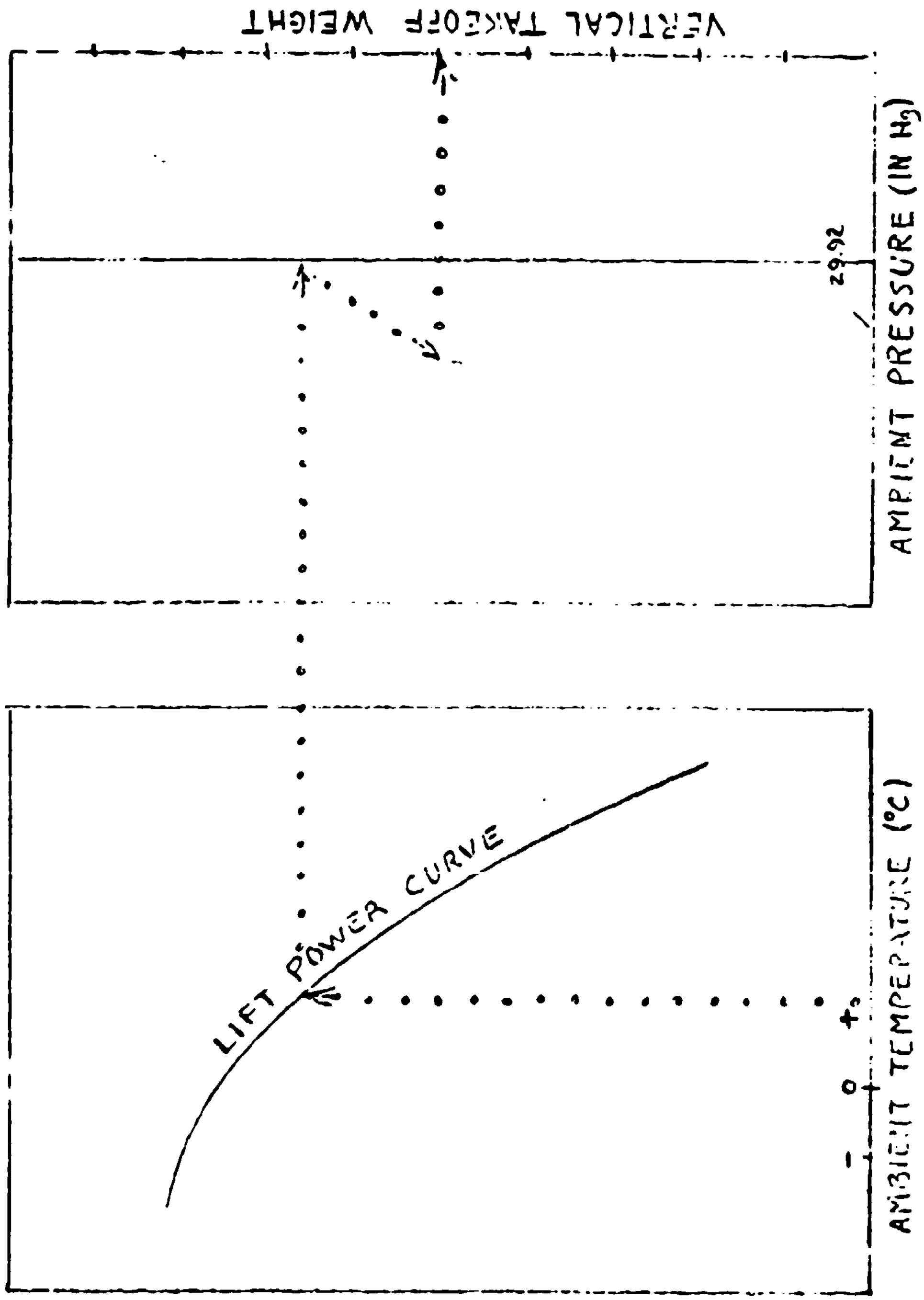
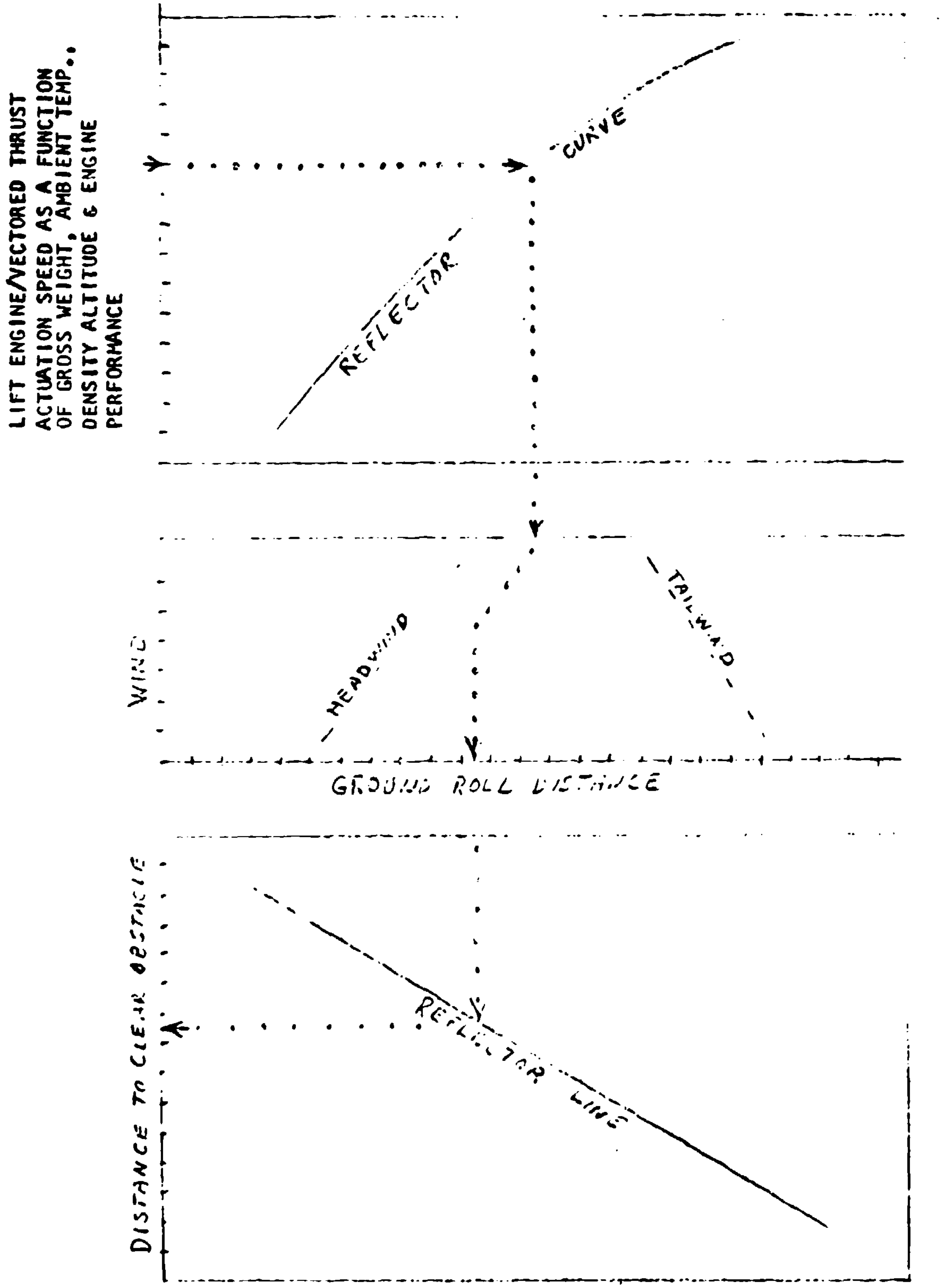


*Figure II-7. Vertical Takeoff Capability



* Figure II-8 (Series). Short Takeoff Distance

ENGINE PERFORMANCE INDEX OR REFERENCE NUMBER
REFLECTS ANY LIMITATIONS AND THE THRUST AVAILABLE
AT VARIOUS AMBIENT TEMPERATURES AND PRESSURES

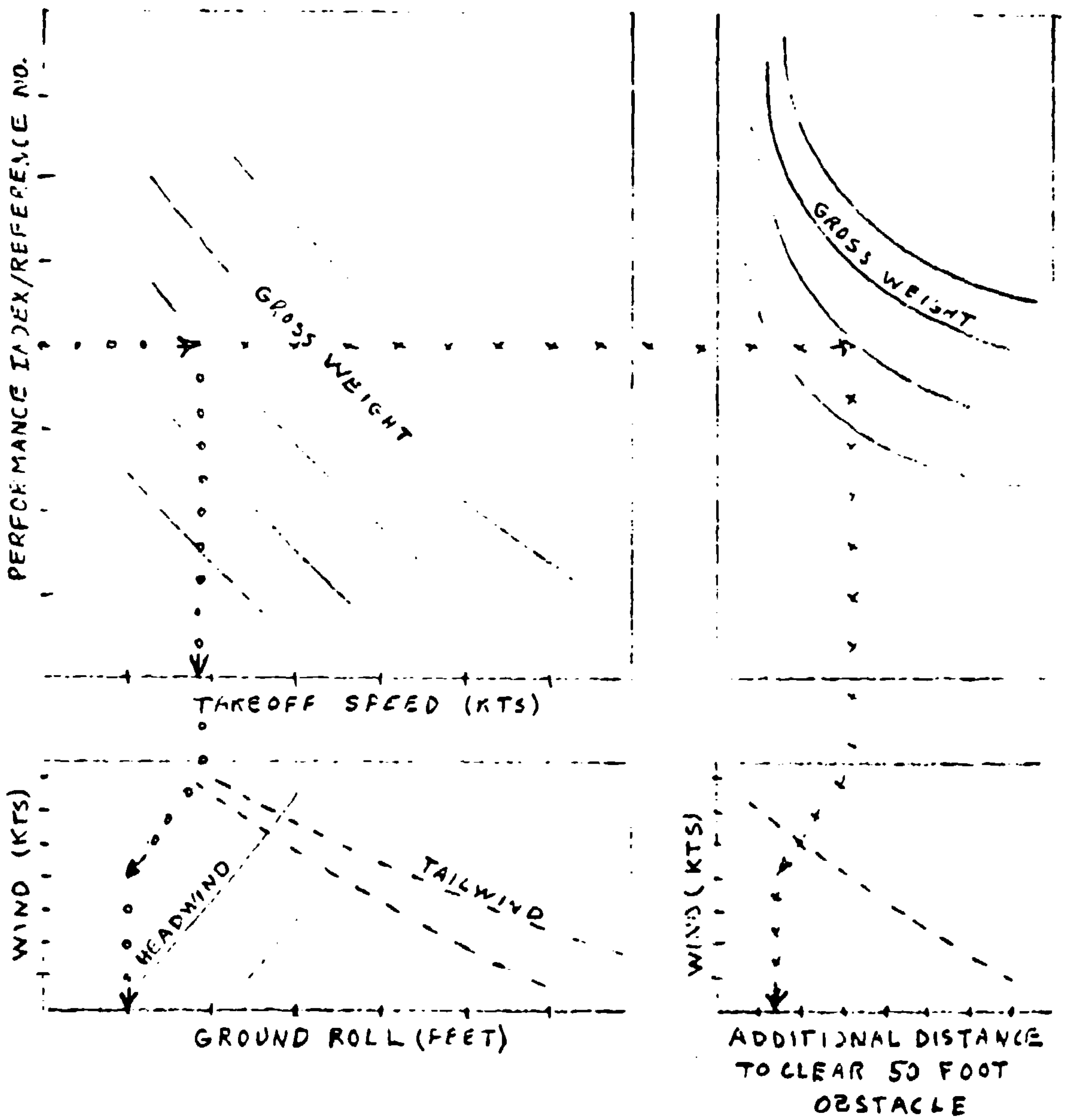


*Figure II-9. Conventional Takeoff

temperatures, density altitudes and WOD. Include a brief description of pilot technique and explain any advantages of rolling/roll-on vertical takeoff versus VTO. Discuss various methods of approach (e.g., stern, offset, cross axial).

A Define minimum wheel-to-deck clearance for transition and identify any visibility/performance problems associated with hovering over the water. What is the optimum WOD for VL? Is the aircraft capable of a VL with no wind on a 90° day? What is minimum landing area for VL? What are the weather minimums? Does the aircraft have an all-weather landing capability? What is the recommended sink speed for VL?

*14. Conventional Landing. Plot the distance required to accomplish a conventional landing (thrust angle 0° or fixed) versus ambient temperature, density altitude, gross weight and WOD in Figure II-10. Indicate airborne distance required to clear a 50-foot obstacle, aircraft configuration and limiting pilot techniques.

15. Wave-off Capability. Does the thrust magnitude control and response meet the requirements of MIL-F-83300 (3.2.5.1, 3.2.5.2 and 3.2.5.3)?

16. Glide Distance. Plot or state the glide (zero thrust/powered lift) distance versus altitude for optimum range with aircraft trim and velocity constant, thrust magnitude at zero and no wind.

17. Survival. Does the aircraft have a hydrodynamic capability or incorporate flotation devices? Is the aircrew escape system capable of safe underwater ejection or other mode of egress?

*18. Visual Landing Aids. Is the aircraft equipped with a precision hover positioning system? Does the proposed aircraft have an automatic landing system incorporated? Does the proposed aircraft require VLA that are not listed in current VLA bulletins to achieve all-weather capability? Provide a list of visual landing aids and deck markings
A required for day/night STO/VTO/VL.

19. Barricade Capability. Can recovery be made using a standard barricade (shorebased/shipboard)? If so, what is maximum aircraft gross weight, engaging speed, and minimum runout required?

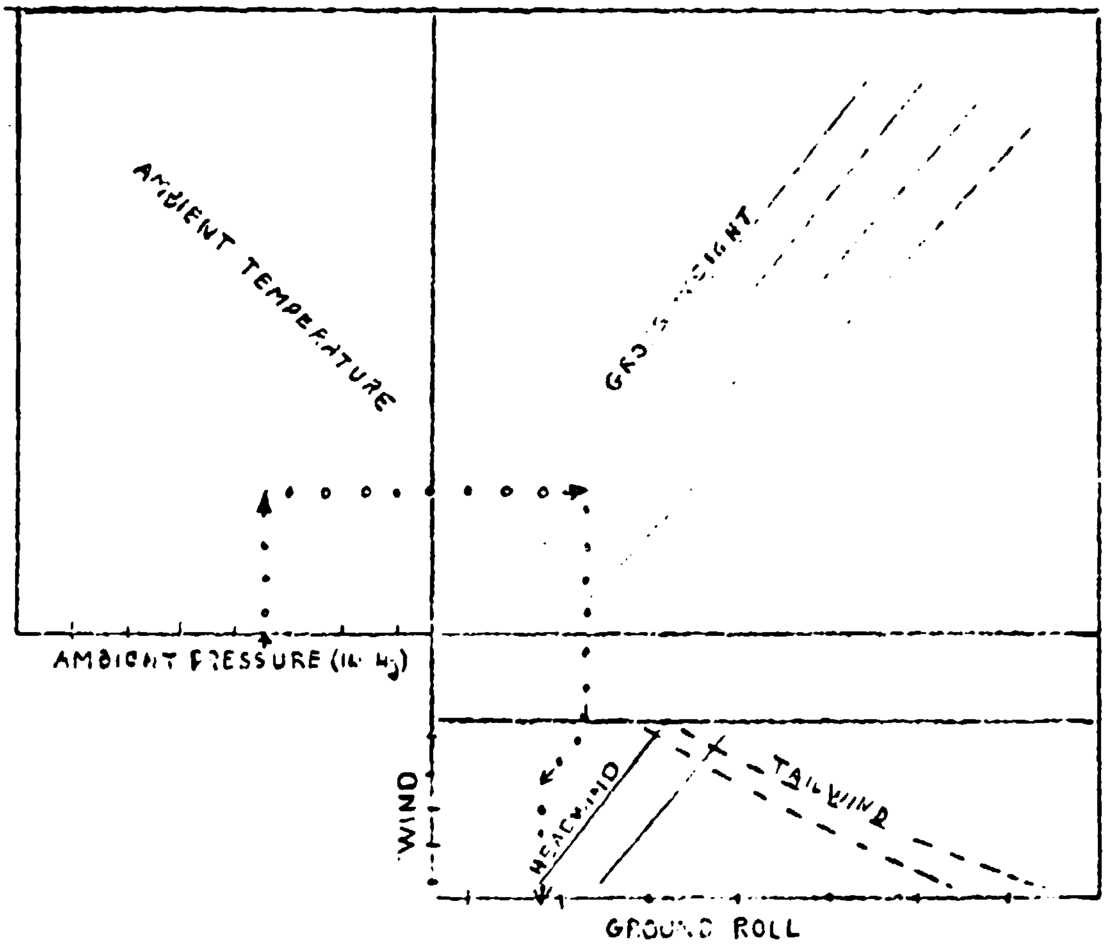


Figure II-10. Conventional Landing

20. Catapulting. Provide the following information for aircraft with a ship or landbased catapult (or launcher assist) capability?

a. Aircraft Catapulting Design Limit Acceleration ______________ (G's)

b. Aircraft Limit Horizontal Catapulting Tow Force ______________ (lbs.)

c. Maximum Permissible Catapulting Weight ______________ (lbs.)

d. Nose Wheel Off-Center Spotting Limit ______________ (inches)

e. Main Wheel Off-Center Spotting Limit ______________ (inches)

f. Holdback Release Load ______________ (lbs.)

g. Recommended Excess Air Speeds ______________ (knots)

h. Nose Wheel Tire Pressure (Carrier Based) ______________ (psi)

i. Main Wheel Tire Pressure (Carrier Based) ______________ (psi)

j. Nose and Main Gear Friction Forces
(Piston/Cylinder) ______________ (lbs.)

k. Vertical Stabilizer Max. Rate of Travel ______________ (deg per sec)

l. Horizontal Stabilizer Maximum Rate of Travel ______________ (deg per sec)

m. Time From Nose Wheel To Main Wheel Lift-Off ______________ (seconds)

n. Structural Spring Rate Of Nose Gear Support
Structure In X Direction ______________ (lbs./in.)

o. Structural Spring Rate Of Nose Gear Support
Structure In Y Direction ______________ (lbs./in.)

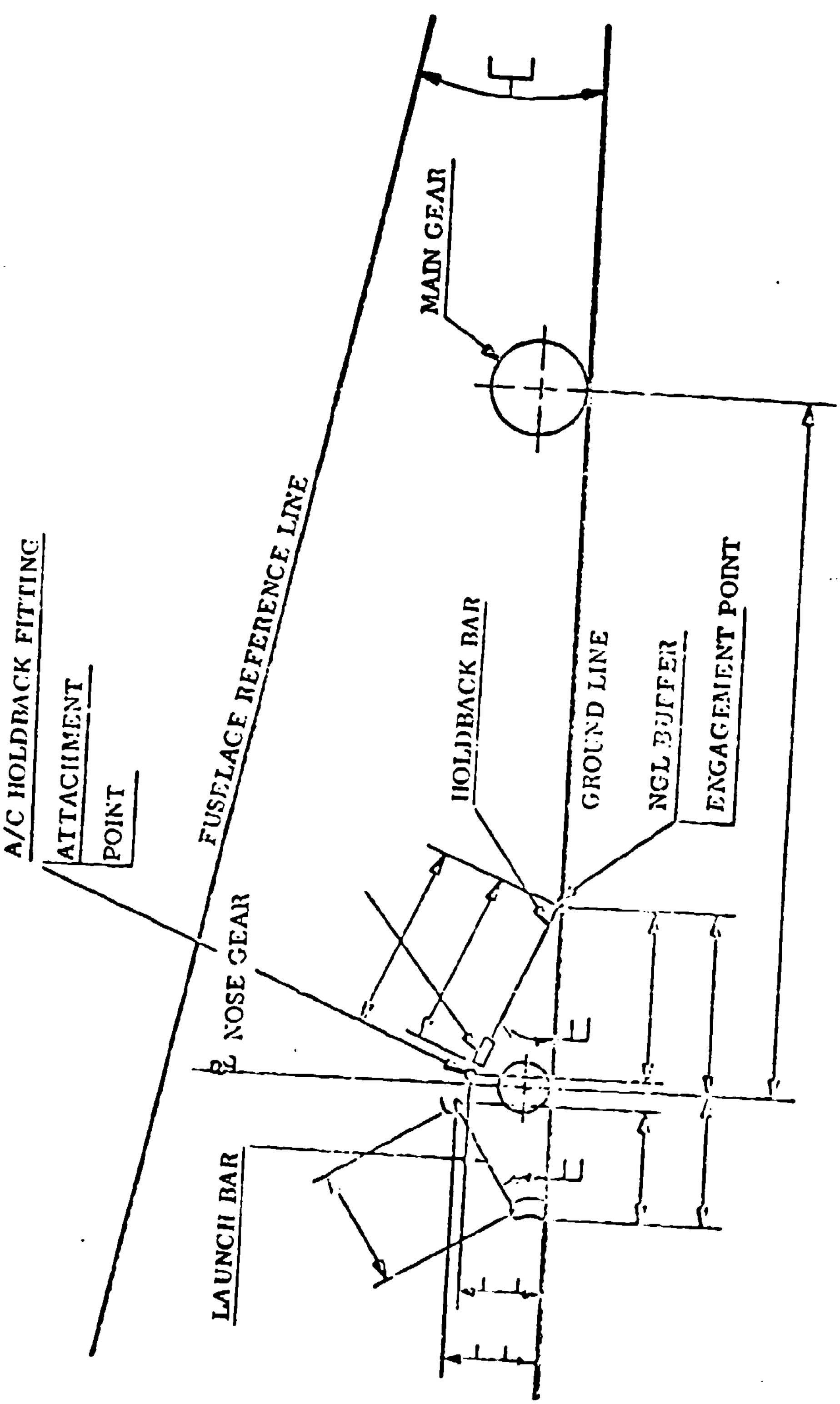
p. Structural Spring Rate Of Nose Gear Support
Structure in Z Direction ______________ (lbs./in.)

q. Structural Spring Rate of Main Gear Support
Structure In X Direction ______________ (lbs./in.)

r. Structural Spring Rate Of Main Gear Support
Structure In Y Direction ______________ (lbs./in.)

s. Structural Spring Rate Of Main Gear Support
Structure In Z Direction ______________ (lbs./in.)

21. Launch Data. The following geometric data and curves for the aircraft in the STO, catapult and tiedown modes are required to determine feasibility of shipboard operations and compatibility with proposed or installed shipboard/shorebased launch equipment and tiedown fitting arrangements (Figures II-11 through II-36, as applicable).



SHIPBOARD LAUNCH GEOMETRY

Figure II-11

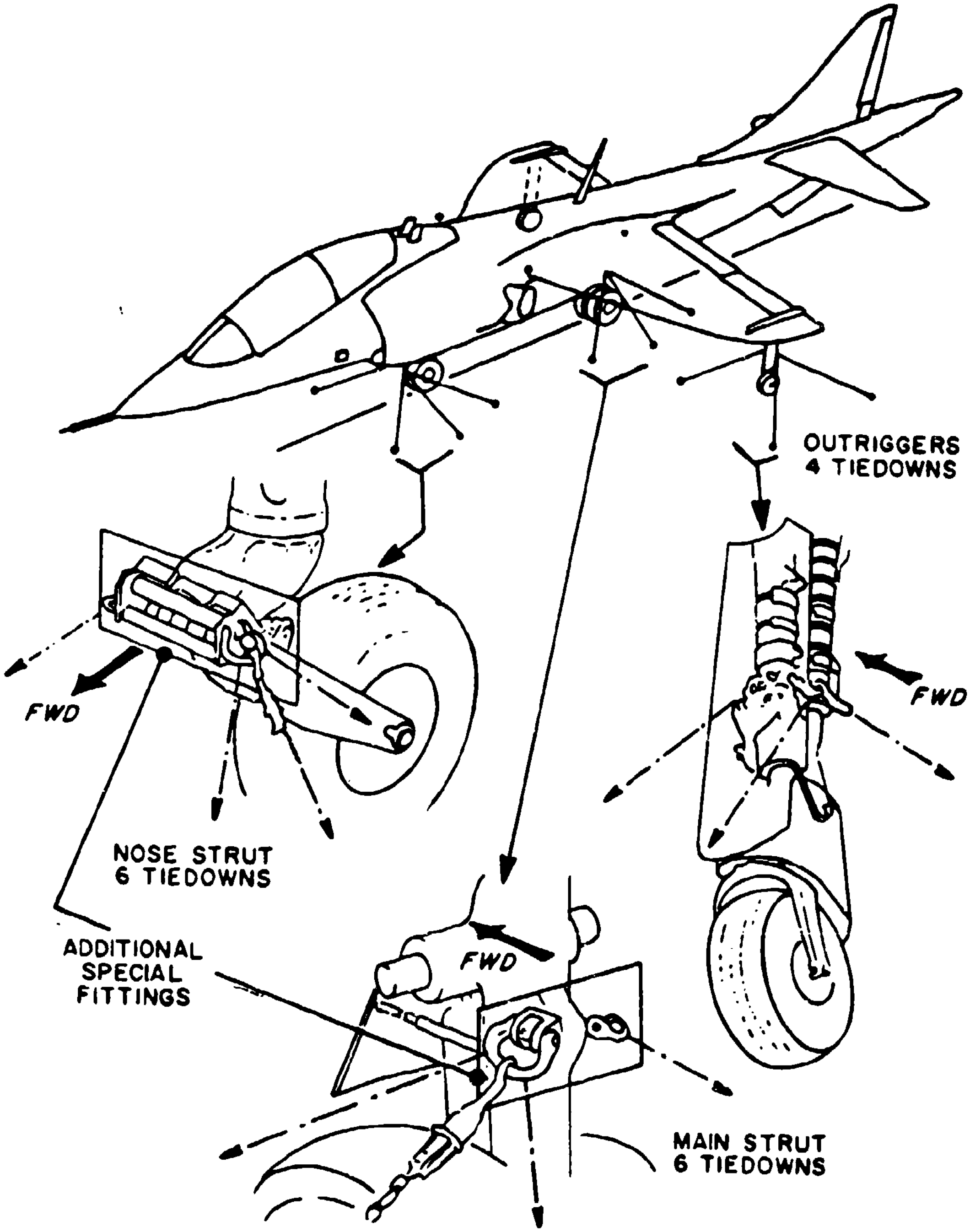


Figure II-12. Shipboard Heavy Weather Tiedown
(Typical)

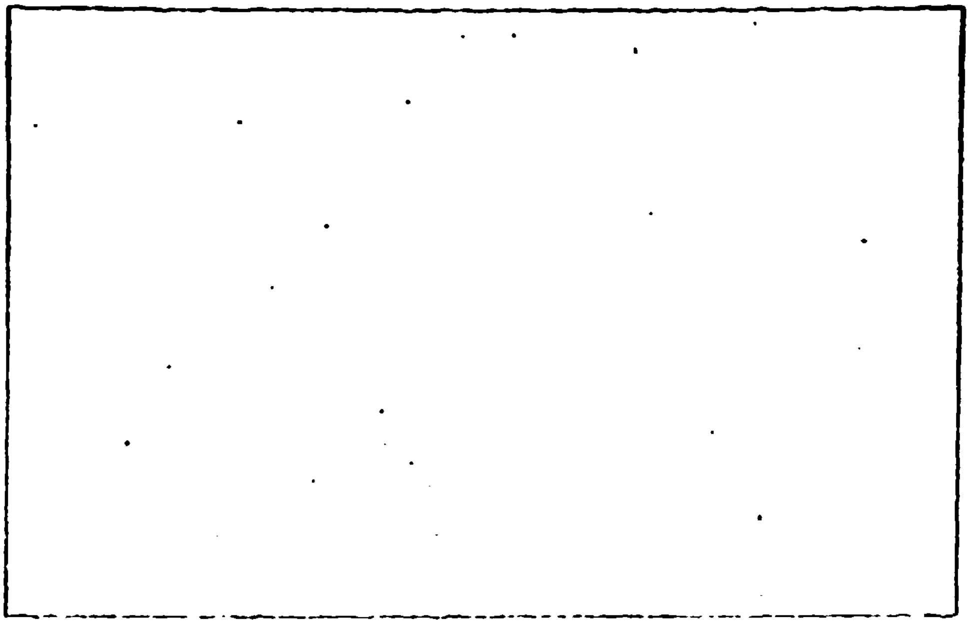


Figure II-14

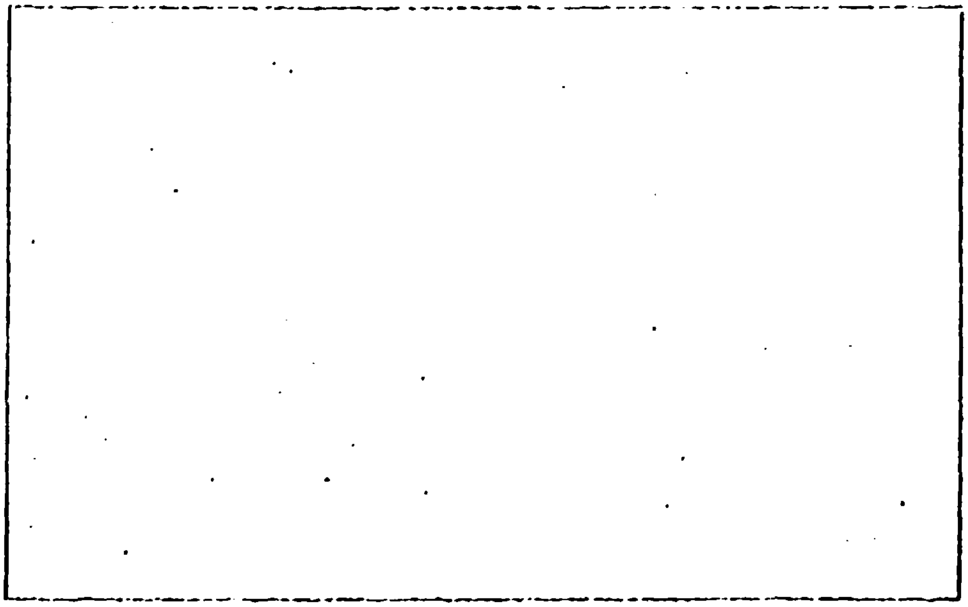


Figure II-13

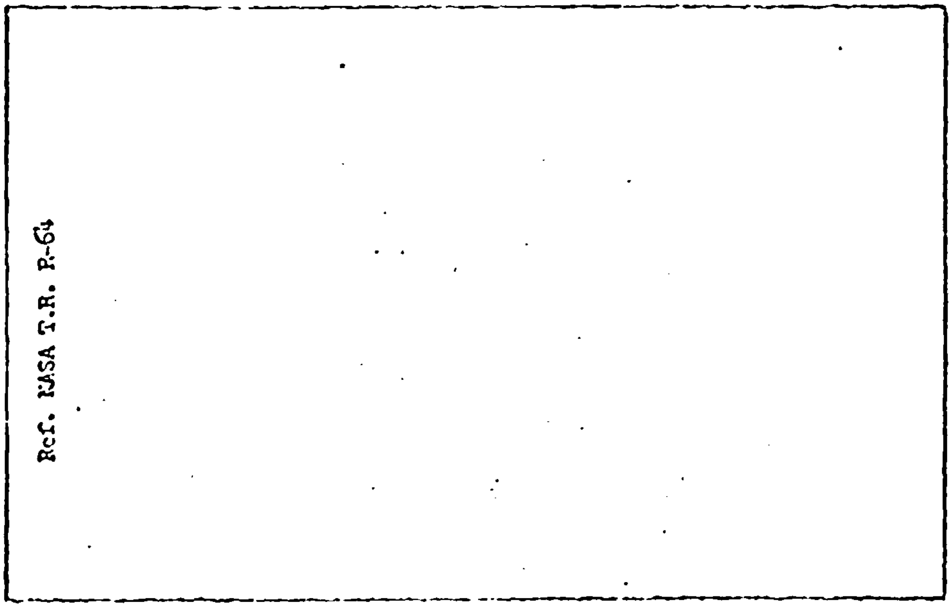


Figure II-15

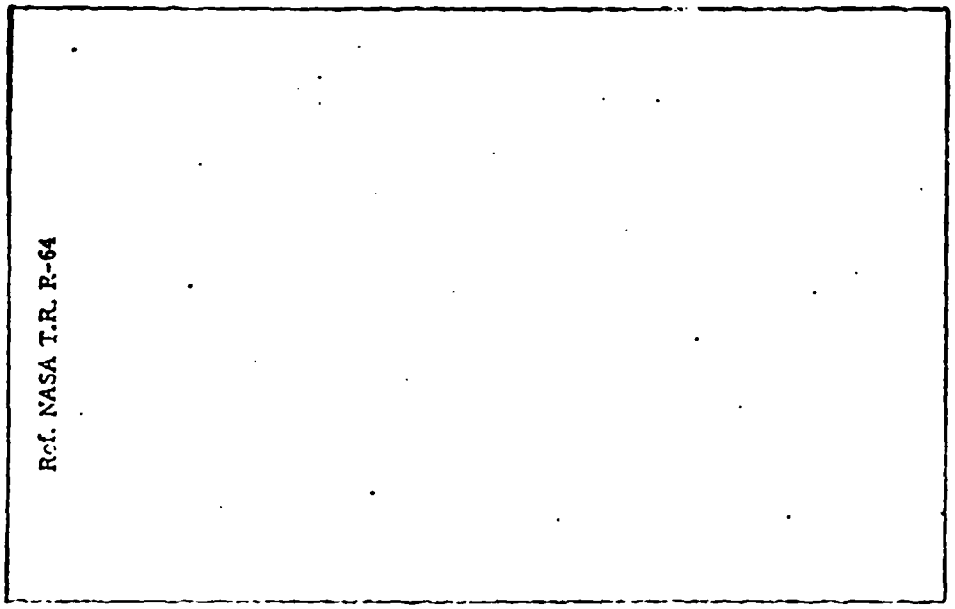


Figure II-16

Normal Force Parameter
Vs Yaw Angle Parameter

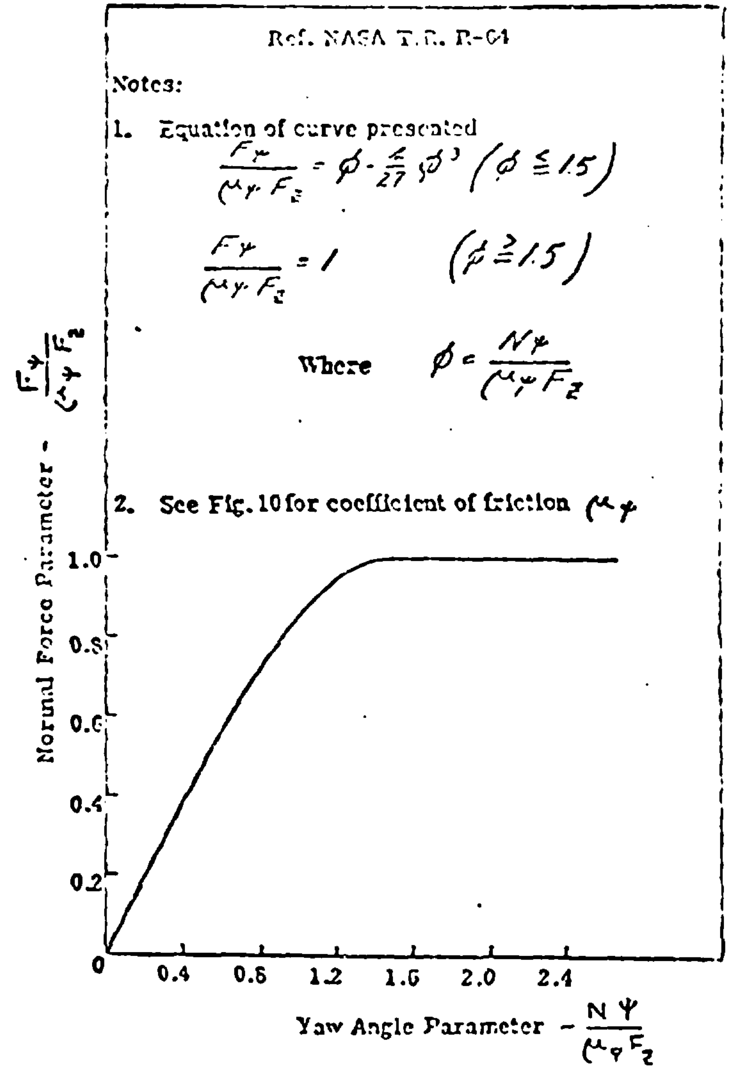


Figure II-17

Lift Coefficient Vs Angle Of Attack In The Take-Off & Landing Attitude For Various A/C Configurations

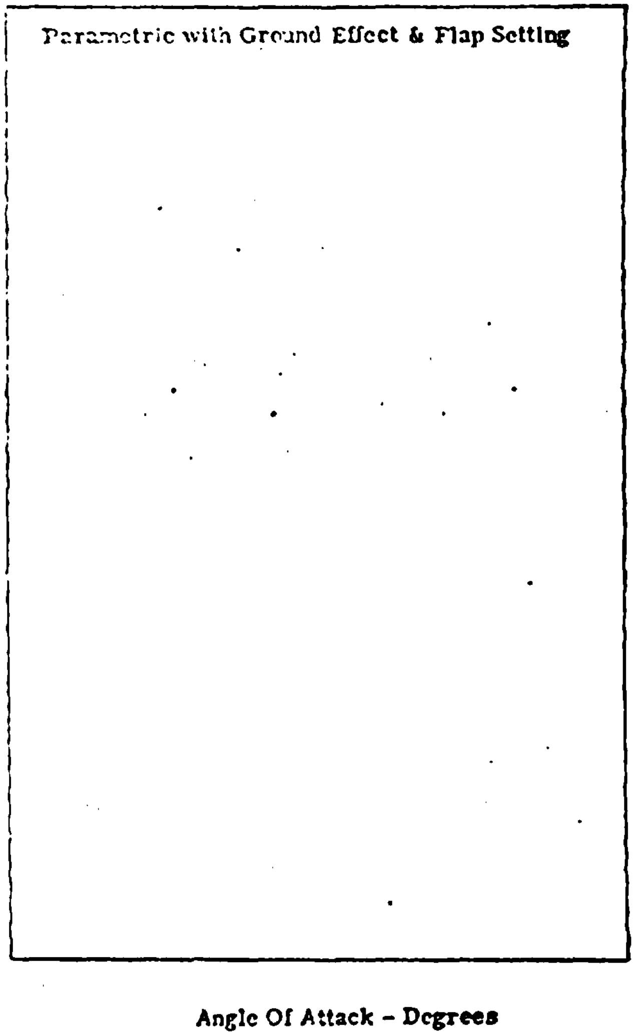


Figure II-18

Pitching Moment Coefficient

Parametric with Ground Effect & Flap Setting

Figure II-19

Pitch Damping

Parametric with Ground Effect, Flap Setting & AOA

Figure II-20

Parametric with Ground Effect, Flap Setting & AOA

Yawing Moment Due to Yaw Velocity (Yaw Damping)

Figure II-21

Rolling Moment Due to Yaw Velocity

Figure II-22

Side Force Due to Yaw Velocity .

Parametric with Ground Effect, Flap Setting & AOA

Figure II-23

Yawing Moment Due To Rolling Velocity

Figure II-24

Rolling Moment Due To Roll Velocity (Roll Damping)

Side Force Due To Rolling Velocity

Parametric with Ground Effect, Flap Setting & AOA

Figure II-25

Figure II-26

Parametric with Ground Effect, Flap Setting & AOA

Yawing Moment Due To Side Slip

Figure II-27

Rolling Moment Due To Side Slip

Figure II-28

Parametric with Ground Effect, Flap Setting & AOA

Side Force Due To Side Slip

Figure II-29

Yawing Moment Due To Rudder Deflection

Figure II-30

Rolling Moment Due To Rudder Deflection

Side Force Due To Rudder Deflection

Parametric with Ground Effect, Flap Setting & AOA

Figure II-31

Figure II-32

Parametric with Ground Effect, Flap Setting & ACA

Yawing Moment Due To Aileron Deflection

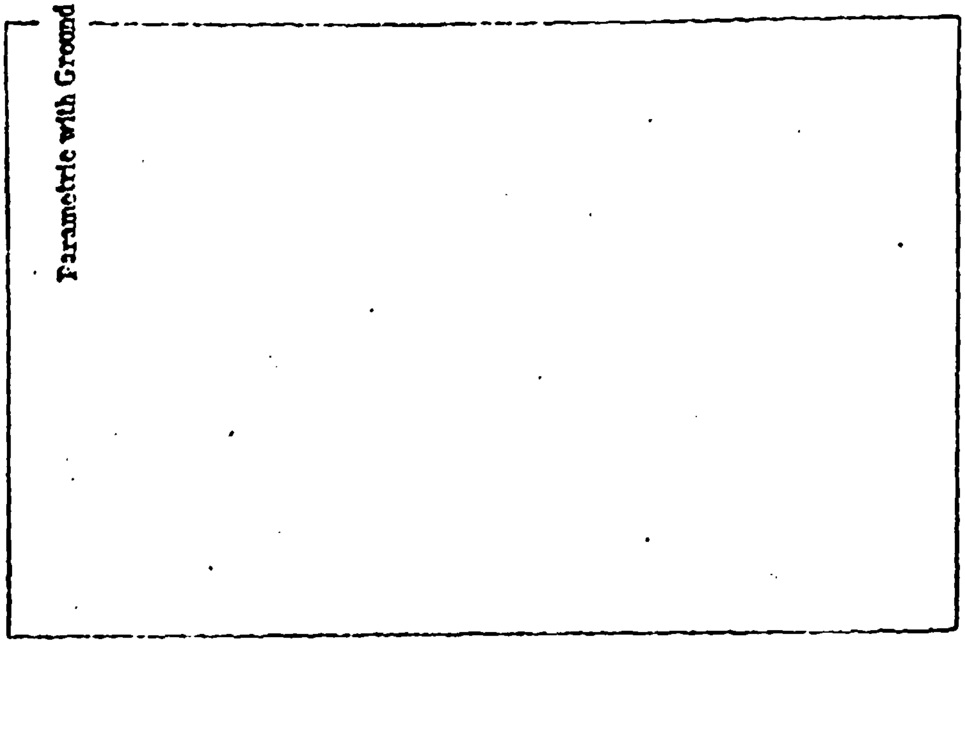


Figure II-33

Rolling Moment Due To Aileron Deflection

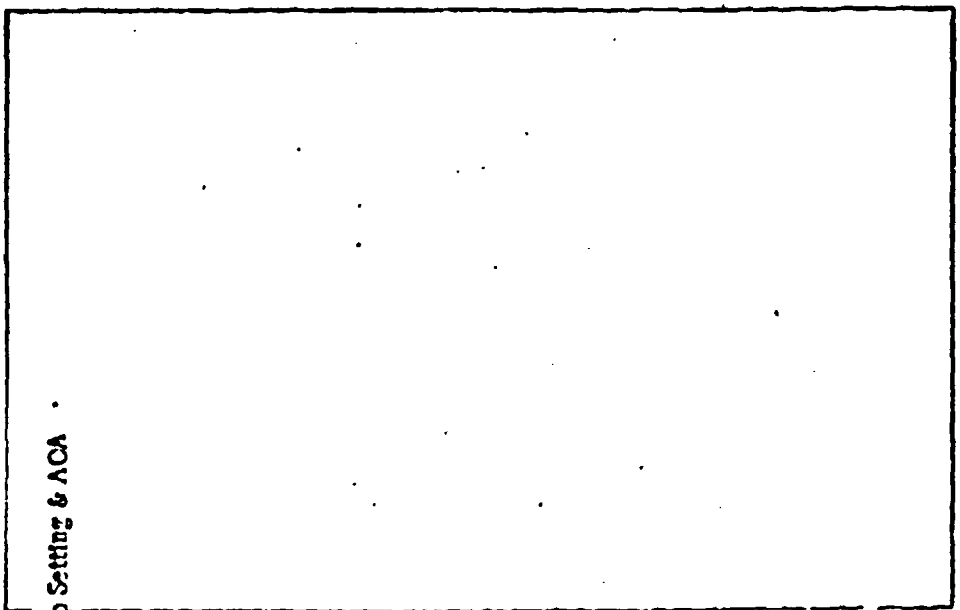


Figure II-34

Side Force Due To Aileron Deflection

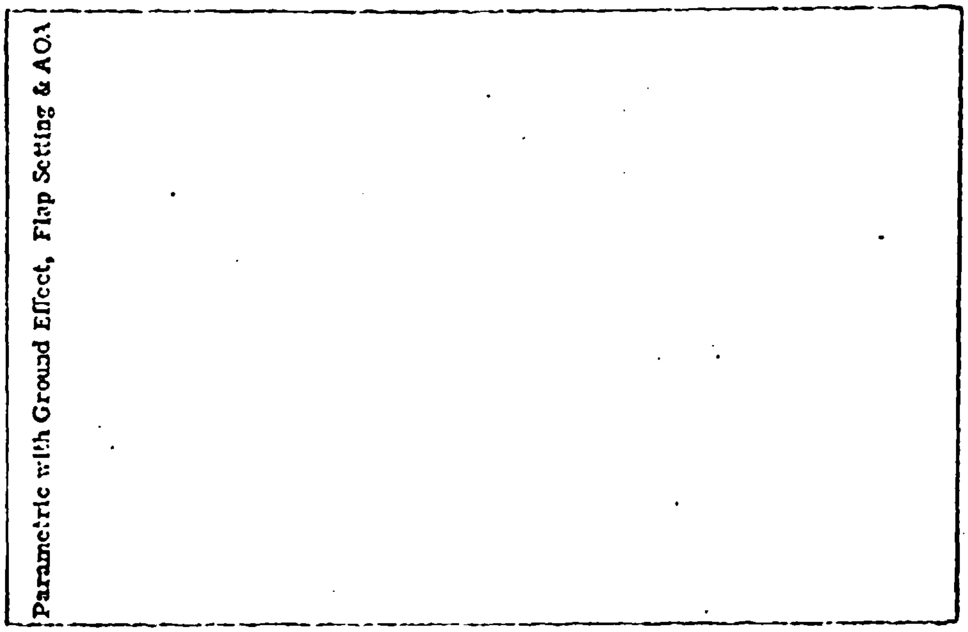


Figure II-35

Minimum Catapult Take-Off Airspeed

Figure II-36

22. Arrested Landing. For aircraft that have a shipboard/shorebased arrested landing or barricade capability, provide the arrangement drawing requirements of MIL-I-18717 and identify as Figure II-37 (series) for inclusion in this report.

23. Arresting Hook Parameters. Provide plots to depict the Arresting Hook Damper Moment Arm (inches) versus the Arresting Hook Position (degrees relative to perpendicular to FRL) in Figure II-38 and the Arresting Hook Damper Force (lb x 1000) versus Hook Rotation Velocity (radians/second) in Figure II-39.

24. Approach Airspeed. Provide a curve to depict carrier landing approach speeds as a function of aircraft gross weight and aircraft configuration on ICAO standard day in Figure II-40.

*25. Arresting Gear. The following data is required to determine limitations of the aircraft/carrier/arresting gear operational interface:

a. Aircraft Limit Horizontal Drag Load Factor at C.G. __________ (G's)

b. Aircraft Arresting Hook Limit Horizontal Drag Load __________ (lb)

*c. Aircraft Ultimate Sink Speed Strength __________ (wt in kips-ft/sec)

d. Recommended Glide Slope Approach Angle __________ (degrees)

e. Recommended Hook to Eye Value __________ (ft-in.)

f. Minimum Recommended Hook to Ramp Clearance __________ (inches)

g. Maximum Permissible Arrested Landing Weight __________ (lb)

h. Maximum Diameter Of Cross-Deck Pendant Accepted By Hook __________ (inches)

i. Aircraft Attitude At Touchdown __________ (degrees)

j. Mass Rotational Inertia Of Hook Shank And Point About Arresting Hook Pivot Point Attachment To Aircraft __________ ($slug\text{-}ft^2$)

k. Damping Coefficients For Tires __________ (lb-sec/in.)

l. Damping Coefficients For Oleo __________ (lb-sec/in.)

Damper Moment Arm Vs
Arresting Hook Position

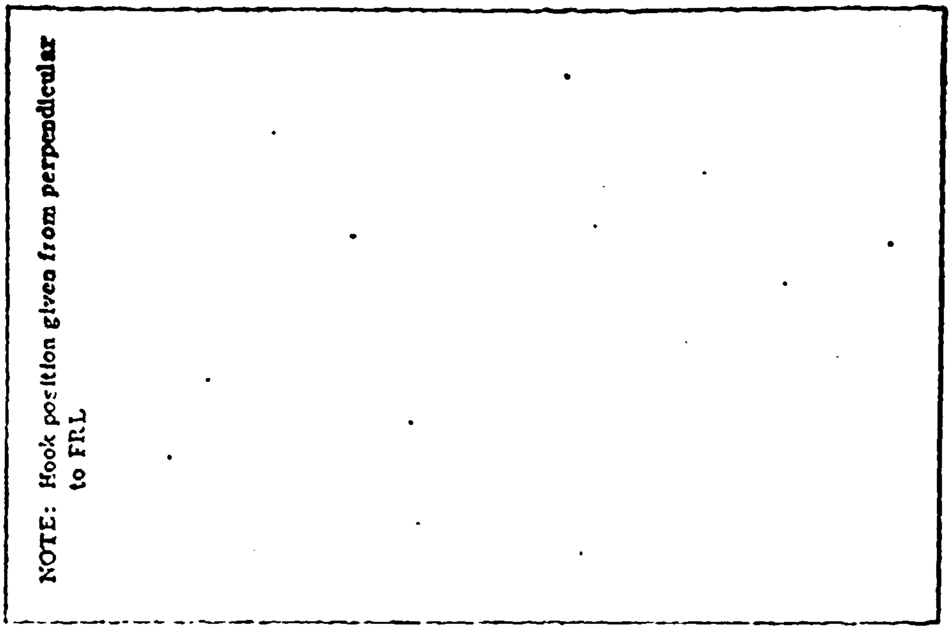


Figure II-39

Arresting Hook Snubber (Damper) Force
Vs Rotational Velocity Of Hook

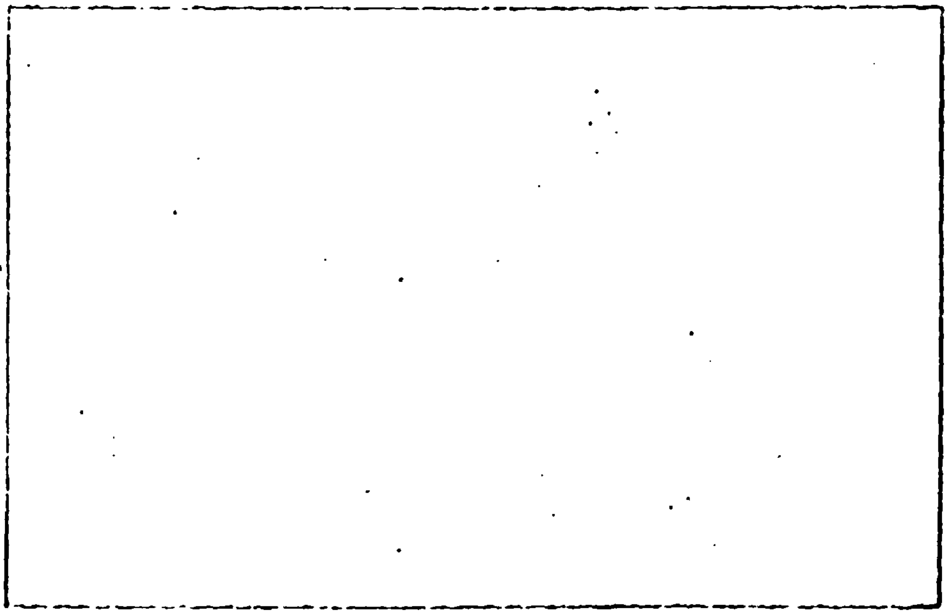


Figure II-38

**Recommended
Carrier Landing Approach Speeds**

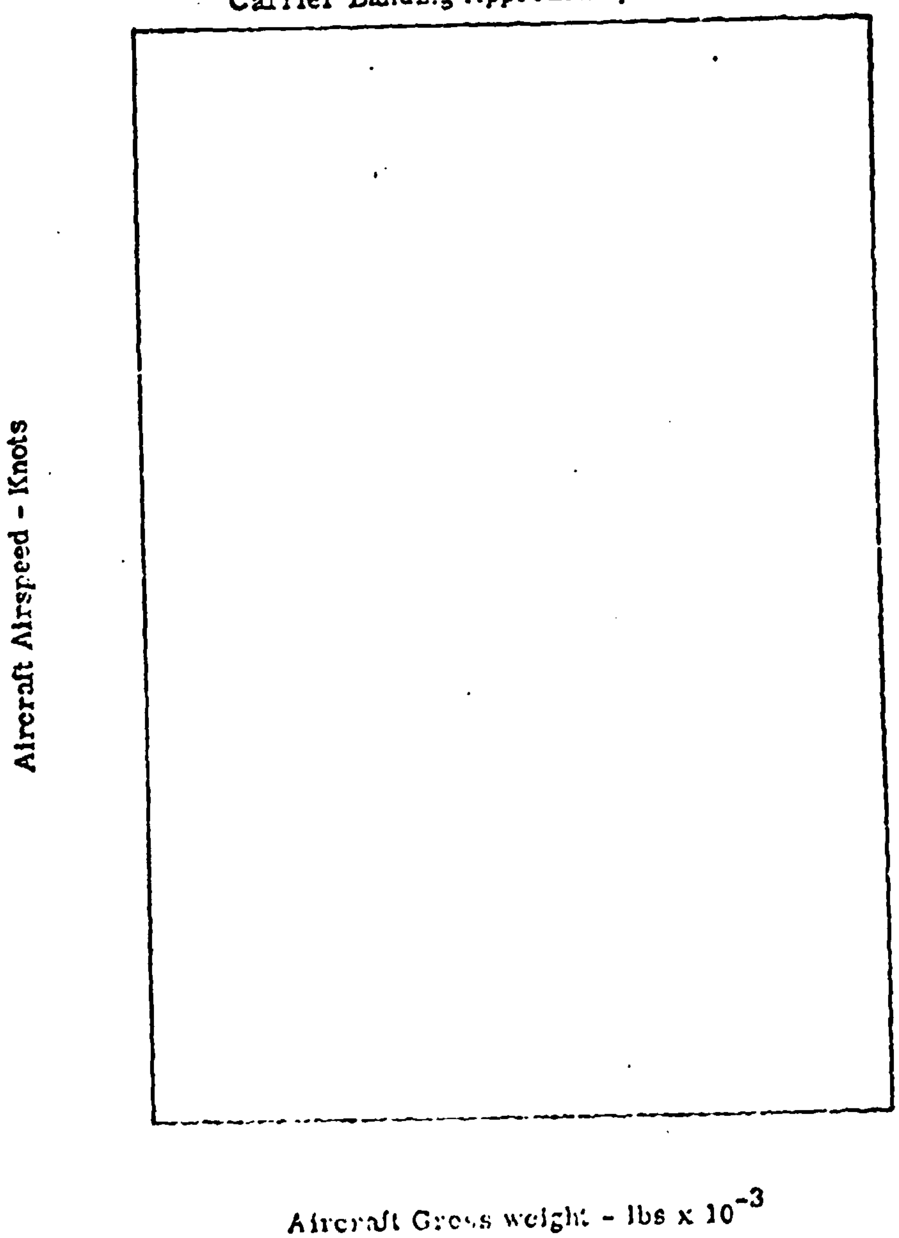


Figure II-40

*26. Ski Jump. Plot the required takeoff distance for STO utilizing a shipboard ski jump (100 ft. circular arc, 12° exit angle) as a function of aircraft gross weight, aircraft configuration, ambient temperature, density altitude, thrust magnitude, thrust angle, and WOD. Provide additional plots or information regarding critical trim settings that influence the takeoff. Indicate the basis of data presented and identify as Figure II-41 (Series). What is the average payload increase over and above maximum gross weight that can be safely achieved for each 50-foot increase in deck run? What is the average payload increase that can be safely achieved for each 5-knot increase in WOD (span 0 to 45 knots)? What are the weather minimums? State the recommended pilot technique and procedures? Provide headwind, crosswind, and tailwind limits. Is an operable HUD and SAS required? Identify the minimum recommended clearances. How does ship motion affect the launch? What deck markings would be required? What modifications to the aircraft would be required for compatibility?

A

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	I-7, I-8, I-9, I-16, I-17, I-19, I-20, I-21, I-22,	
	I-23, II-3, II-6, II-10, II-12, II-13, II-14, II-27, II-30	